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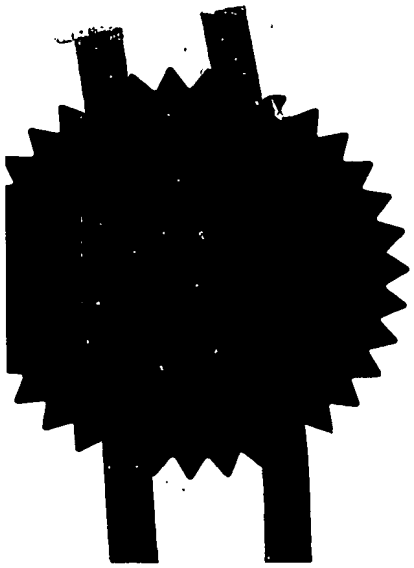

Signed P. Mahoney

Dated 9 January 2004

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P01/7700 0.00-0313590.2

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1. Your reference — P102836GB

2. Patent application number *(The Patent Office will fill in this part)* — 0313590.2

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — Freedom Innovations Limited
48 Suffolk Road
Sheffield
South Yorkshire S2 4AL United Kindom

08628695001
Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — HAIRDRYER

5. Name of your agent *(if you have one)* — LUNT, Mark George Francis

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* — Harrison Goddard Foote
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Leopold Street
SHEFFIELD
S1 2QD, United Kingdom

Patents ADP number *(if you know it)* — 7914237001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
WO	PCT/GB2002/005498	06/12/02
GB	0310700.0	09/05/03

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
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Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 12 June 2003

Mark G F LUNT

12. Name and daytime telephone number of person to contact in the United Kingdom — MARK LUNT — 0114 274 3701

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Hairdryer

This invention relates to hairdryers.

Our co-pending international patent application number PCT/GB2002/005498 describes a cordless hairdryer having a gas supply burning through a catalyst and a motor driven fan providing air flow. A control system is also described that provides various safety features.

A 'cool shot' is a term of the hair-dressing art. Hairdryers often provide this function, in which power is momentarily disconnected from the heater element, but the fan continues to blow. Ambient temperature air is then blown, and this has application in some instances. Normally, a button is provided on the side of the housing that, while held activated, provides the cool shot. Our copending application identified above suggests that the cordless hairdryer described can have this feature by turning on or off the gas supply.

However, this involves reigniting the burner and, unless some automatic control system is employed, it will involve the user releasing the cool shot button and pressing an ignition button when the cool shot is to end and normal hot air operation is to be reinstated.

On a different subject, a distinct problem to be overcome for gas-burner hairdryers is temperature control. This requires accurate regulation of the gas flow. Gas, of course, in canisters, is stored in liquid form, and a corollary problem is that regulators occasionally release a plug of liquid, which, once evaporated, is substantially more gas than would have

been permitted to flow through the regulator had gas flowed, rather than liquid.

Our co-pending application mentioned above includes the possibility of pulse width modulation providing heat level control by regulating the on/off periods of a solenoid activated valve in a gas conduit.

In one aspect, the present invention provides a hairdryer comprising a housing defining an air passage; a battery adapted to power a motor; a fan driven by the motor to drive air down the air passage; a burner in the air passage to heat the air flowing through the passage; a conduit providing combustible gas flow to the burner; a regulator to control the gas flow between no-flow, minimum-flow and maximum-flow levels; wherein the hair dryer has at least three modes of operation: in a first of which it is off, and said regulator prevents any flow of gas; in a second of which said regulator permits gas to flow at a normal level between said minimum and maximum levels, whereby ambient air at 20C flowing past the burner is heated to at least 40C; and in a third of which said regulator permits gas to flow at said minimum level, whereby ambient air at 20C flowing past the burner is heated to no more than 30C. Said normal level may be said maximum-flow level.

Thus the present invention suggests not to cut-off the gas supply completely, but merely to reduce it to such a level that the gas combustion can be reliably maintained while the cool shot function is operating. Resumption of normal heat is then simply a matter of switching off the cool shot function, whereupon the gas flow is restored to its normal level. There is no requirement to reignite the gas.

The minimum gas flow found capable of being reliably maintained is sufficiently small that the air flowing through the hairdryer is not heated to a significant extent. While not being a 'cold' shot, it is nevertheless a 'cool' shot, to all intents and purposes. Of course, any gas flow less than the maximum is likely to less reliably maintain combustion in the burner. Consequently, what is meant by "the gas combustion can be reliably maintained" is somewhat arbitrary, but should be understood to mean that, under normal operating conditions, the combustion does not usually extinguish.

Put another way, the invention in this aspect provides a hairdryer comprising a housing defining an air passage; a battery adapted to power a motor; a fan driven by the motor to drive air down the air passage; a burner in the air passage to heat the air flowing through the passage; a conduit providing combustible gas flow to the burner; a regulator to control the gas flow between no-flow, minimum-flow and maximum-flow levels; wherein the hair dryer has at least three modes of operation: in a first of which it is off, and said regulator prevents any flow of gas; in a second, normal mode, said regulator permits gas to flow at a normal level between said minimum and maximum levels, whereby ambient air flowing past the burner is heated to a hair drying temperature; and in a third cool shot mode, said regulator permits gas to flow at said minimum level, whereby ambient air flowing past the burner is not significantly heated but sufficient gas is supplied to keep said burner alight.

Reliable gas flow, particularly at said minimum level, is a precondition of the aforesaid cool shot function, as any interruption or surge in the gas flow

may well extinguish combustion and there will not be adequate heat in the burner to ignite the gas flow when its flow resumes at the normal minimum level.

In a second aspect, the present invention provides a hairdryer comprising: a housing defining an air passage; a battery adapted to power a motor; a fan driven by the motor to drive air down the air passage; a burner in the air passage to heat the air flowing through the passage; a manifold for connection of a removable gas canister; a conduit providing combustible gas flow to the burner from the canister, when connected; a solenoid; a valve in the conduit operated by the solenoid; electronic control means pulsing the solenoid between on and off positions of the valve, wherein said control means is adapted to adjust the period of said respective on and off positions between conditions of no-flow and maximum-flow of gas in the conduit.

Preferably, said control means also provides a minimum-flow level of gas intermediate said no-flow and maximum-flow levels.

Preferably, a flow restrictor is provided in the conduit adjacent to the burner and remote from the valve, so that a substantially constant gas pressure subsists downstream of the restrictor for all flows of gas.

Apart from providing an effective means of gas flow regulation, which is particularly of benefit in the aforementioned cool shot function, the invention in this second aspect has the advantage of being able to employ currently, and widely, available gas valves as used in cigarette lighters.

Therefore, with respect to the first aspect of the invention, said regulator in the case of the second aspect of the invention comprises said solenoid actuated valve and its associated control means.

Instead of an accurately fashioned adjustable flow valve, a pulsed "On-Off" of a simple valve, for variable periods of time, provides the conduit upstream of the valve with high pressure gas 'plugs'. These maintain a flow through the restrictor in dependence upon the average pressure of the gas in the conduit. The basic requirement is that no Off period (other than when the hairdryer is actually turned off) can be so long that the gas pressure upstream of the restrictor decays to such a level that flow through the restrictor stops. The length of Off-periods could be longer with longer On-periods, but this ultimately results in varying flow through the restrictor (and therefore varying heat output) which may not be desirable. On the other hand, rapid On-Off periods, while giving smoother gas flow, results in excessive wear of the valve.

The invention may also comprise a gas canister having a closure valve in its outlet and said manifold may comprise an inlet having a port for connection to said gas canister and adapted to open said outlet valve on connection of the canister to the hairdryer.

In a third aspect, the present invention provides a

hairdryer comprising: a housing defining an air passage; a batt ry adapted to power a motor; a fan driven by the motor to drive air down the air passage; a burner in the air passage to heat the air flowing through the passage; a manifold for connection of a removable gas cartridge; valve openers in the manifold; a conduit providing combustible gas flow to the burner from the manifold; a valve in the conduit to control flow of gas in the conduit between no-flow and maximum-flow conditions; a cartridge receptacle; and a first coupling part on the housing, and wherein said gas cartridge comprises: a plurality of gas canisters disposed in side-by-side relation, each canister being substantially cylindrical with a neck at one end terminating in an outlet valve; alignment means comprising neck rings and an end cap, wherein the neck rings bind the necks of the canisters together and the cap secures the bases together; and a second coupling part on the cap, wherein the first and second coupling parts engage one another on insertion of the cartridge in said receptacle and engagement of said outlet valves with said valve openers in the manifold whereby a fluid connection is made between the interior of the canisters and said manifold, said coupling parts retaining the cartridge in position and said cap closing said receptacle.

Such an arrangement provides a convenient package of gas canisters where the cap on their base forms an integral component of the housing which is renewed each time the gas canisters are exchanged. Apart from ensuring the continued integrity of the second coupling part by its replacement on each exchange of gas canister, the cap gives opportunities for stylisation of the hairdryer by selecting different colours, patterns, markings etc of the cap.

In this respect, the invention independently provides a gas cartridge as defined above.

This benefit is particularly felt in a preferred arrangement in which the housing comprises a tubular body having a longitudinal axis, an open front end and housing the fan, motor and burner, and a depending pistol-grip handle, housing said battery and control means, said receptacle being disposed beneath the tubular body in front of the handle and aligned so that the canisters in the cartridge are substantially parallel to said longitudinal axis when engaged in said receptacle, said cap facing the front of the hairdryer.

In any of the above aspects, safety controls are preferably provided in which the gas supply is interrupted in the event of detection of over-temperature and/or under-temperature of the burner.

In the case of the first aspect of the invention said safety control is preferably disabled in respect of under-temperature while said cool shot function is operating.

In a fourth aspect, the present invention provides a handheld portable implement comprising a tubular body having a longitudinal axis and a depending pistol-grip handle, wherein components of the implement are housed within the tubular body and handle, and wherein the tubular body comprises two cup elements mating in a direction substantially parallel said longitudinal axis, and said handle comprises two clamshells mating in a direction substantially perpendicular said axis, the clamshells each having an extension which at least

partially surrounds and connects to one or both of said cup elements.

Although such an arrangement has application in a wide variety of implements, it finds particular application in a hairdryer which, being a domestic tool used primarily by or for women, preferably has some aesthetic qualities of design. This arrangement facilitates that aim by enabling various colour schemes to be developed for the implement simply by exchanging colours of the handle versus the tubular body, and possibly the degree of surrounding, and shape thereof, around the body. Moreover, the arrangement also permits ergonomic changes to the handle arrangement on the body without having to redesign substantially the body. Thus a mid-body or end body connection may be suggested, or the fundamental shape of the handle to changed.

Preferably, the implement is a hair dryer as defined in respect of one of the first three aspects of the invention.

Preferably, a frame element is received in the body mounting components of the implement, wherein the frame element has bosses engaged by fasteners passing through one cup element and connecting the clamshells to the cup element. Fixing locations may also be provided on the frame element to connect one or both cup elements thereto.

Where said implement is a hairdryer comprising a fan, a motor to drive the fan, a battery to power the motor, a burner to heat airflow driven by the fan, and a gas canister to supply gas to the burner, said cup elements are open at each end to permit said airflow into

and out of the hairdryer. Also, said motor, fan and burner are preferably mounted in line on said frame element.

The invention is further described hereinafter, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an exploded perspective view of the main components of a hairdryer showing some features according to the present invention;

Figure 2 is a section through the hairdryer of Figure 1;

Figure 3 shows a control and safety circuit diagram for the hairdryer;

Figure 4 shows user controls and indicators for the hairdyer;

Figure 5 shows one possible component format for the hairdryer;

Figure 6 shows an alternative possible format for the components of the hairdryer;

Figure 7a is an exploded diagram showing an alternative format for the hairdryer;

Figure 7b is a schematic side sectional view showing the format of Figure 7a;

Figure 8a is an exploded diagram showing a further alternative format for the hairdryer;

Figure 8b is a schematic side sectional view showing the format of Figure 8a;

Figure 9a is an exploded diagram showing a further alternative format for the hairdryer;

Figure 9b is a schematic side sectional view showing the format of Figure 9a;

Figure 10a is an exploded diagram showing a further alternative format for the hairdryer;

Figure 10b is a schematic side sectional view

showing the format of Figure 10a

Figure 11a is an exploded diagram showing a further alternative format for the hairdryer;

Figure 11b is a schematic side sectional view showing the format of Figure 11a;

Figure 12a is an exploded diagram showing a further alternative format for the hairdryer;

Figure 12b is a schematic side sectional view showing the format of Figure 12b;

Figure 13 is (a) a front view, (b) a plan view, (c) a side view and (d) a rear view of a preferred design of hairdryer;

Figure 14 is an exploded view of the main components of the dryer of Figure 13;

Figure 15 is an illustrational side view of an assembled hairdryer with one side housing removed;

Figure 16 is (a) an external side view, (b) a front view and (c) an internal side view, of a handle clamshell, right side, of a hairdryer according to the invention;

Figure 17 is the same as Figure 16, except reversed and in respect of the left side of the hairdryer of Figure 16;

Figure 18 is (a) a bottom view, (b) a side section, and (c) an internal end view, of a front cup element of the hairdryer of Figure 16;

Figure 19 is (a) a bottom view, (b) an internal end view, (c) a side section, and (d) an extrnal end view of a rear cup element of the hairdryer of Figure 16;

Figure 20 is (a) a side view, (b) a rear end view, and (c) a plan view of a frame element of the hairdryer of Figure 16;

Figure 21 is (a) a side view and (b) a front view of a rear baffle plate of the hairdryer of Figure 16;

Figure 22 is (a) a side view and (b) a front view of

a front baffle plate of the hairdryer of Figure 16;

Figure 23 is (a) a plan view, (b) a front view, (c) a section on the line A-A in Figure 23(b) and (d) a rear view of a manifold of the hairdryer of Figure 16;

Figure 24 is (a) a side view, (b) an internal end view, and (c) a plan view of a battery cartridge cap of the hairdryer of Figure 16;

Figure 25 is a schematic view of the gas flow control arrangement of one aspect of the invention;

Figure 26 is a perspective view of a gas cartridge; and,

Figure 27 is (a) a plan view and (b) a side view of a membrane switch pad for use on the hairdryer.

Referring to Figure 1 and 2, a hairdryer 10 comprises a housing 12 which at one end consists of two clamshell halves 14a,b, a middle, tubular section 16, and an end nozzle 18. In the clamshell end 14 is mounted a motor 20 driving a fan 22. The fan 22 draws air axially through an end aperture 24 (which may be guarded by a grill (not shown) to prevent finger access to the fan 22). The fan 22 expels air radially, but the clamshells 14a, b are shaped so that air exiting the fan 22 is deflected longitudinally into the tubular portion 16 of the housing 12. The arrangement therefore provides a tubular-like flow of air through the air passage 26 defined by the housing 12. Indeed, the motor 20 defines an angular start 26a of the air passage 26.

A cross element 30 is mounted at the entrance to the tubular part 16 of the housing 12. Screws 33 secure the cross in place. Two threaded bores 32 are provided in the cross 30, one above the other, and into each of these is screwed a burner 34.

Each burner 34 compris s a brass collar 36 screwed into the bore 32 and provided with a gas terminal 38. A gas pipe (not shown) from a gas supply (not shown) via a trigger or other supply control mechanism (not shown) is connectable to the terminal 38. The terminal 38 is provided with a narrow bore that opens into the interior of the collar 36, jetting gas therein. A neck 40 of pressed/sintered metal is screwed into the collar 36. Inside the neck 40 is disposed a plug 42 of porous metal that serves to regulate gas flow through the burner 34. On exit from the plug 42 gas flows along a bore 44 of the neck 40 where it mixes with air drawn in through a cross bore/port 46.

Air is drawn into the port 46 by virtue of the low pressure in the bore 44 caused by the high velocity gas flow therein and controlled by the plug 42. A stoichiometric volume of gas and air therefore flows along the neck 40 and enters sleeve 50. Finally, in a broad section 52 of the sleeve 50 is disposed a coiled catalytic wire, coated with platinum (not shown), where the combustible gas mix combusts in the absence of a flame. Alternatively, and this is presently preferred, the catalyst is in the form a grid across the end of the section 52.

Finally, the combusted gases exit the burners 34 and impinge on a ceramic block, or pressed steel, baffle 54 to be deflected radially outwardly so as to mix with the tubular air flow caused by the fan 22.

A second baffle 56 is provided around the sleeves 50 to further define the tubular flow by defining annular space 26c of the air passage 26. The second baffle 56 prevents the air flow from directly contacting the

burners 34 in the region of the cups 52 where the catalyst is disposed. This ensures that the catalyst remains at the requisite temperature to guarantee complete combustion of the combustible gas. As shown, the baffle 56 is mounted on one of several fins 58 of each burner 34, especially that one closest to the cup 52. However, it could equally well be mounted on its own spider from the internal surface of housing part 16.

The fins 58, which also extend to the neck 40, serve to shed heat developed in the burner cup 52 and conducted along the material of the burner 34. This heat is shed by both convection with the surrounding air flow, as well as by radiation. Indeed, the latter is more significant given a third baffle 60 which is, like the baffle 56, a disc having a cupped edge. This also defines the tubular air passage by annular space 26b. The baffle 60 is held against the cross 50 by the burners 34 passing through apertures (not shown) in the baffle 60. The baffle 60 guards the ports 46, and prevents air flow, driven by the fan 22, from drawing gas out of the ports 46. Instead, stagnant air behind the baffle 60 is at a relatively high pressure compared with the gas flowing through the bore 44 of the neck 40 of the burners 34.

Returning to the first baffle 54, it is mounted on a rod 62 and a further cross 64 inside the tubular housing part 16. On the end of the housing part 16, a nozzle 18 is disposed, which maybe shaped to further enhance mixing.

As noted already, there are two burners 34, each expelling hot exhaust gases against the baffle 54. The baffle 54 has a ridge 66 aligned with the line joining the longitudinal axes of each burner. Most of the

outflow from each burner is shed to one side or the other of the ridge 66. However, a hip 68 is formed on the baffle 54 at either end of the ridge. Gases exiting a sector of each burner remote from the other burner are thus deflected at right angles to the ridge-deflected gases. This spreads the infiltration of the hot gasses into the air flow, so that more effective mixing occurs with less likelihood of hot spots occurring.

The baffle 54 is terminated by a blunt end 70, so that airflow around it is turbulent, further enhancing gas mixing and temperature stabilisation.

As discussed above, in overview the hairdryer includes a gas burner and gas reservoir and a fan. In addition, as discussed in more detail below, a control circuit and a battery for powering the fan are provided. A first baffle shrouds the burner, preventing airflow from cooling the burner. A second baffle deflects combusted gas exiting the burner so that it mixes with air flowing around the burner.

Figures 5 to 12 show various product configurations in schematic form for a hairdryer according to the invention, with the housing and control components not shown, for clarity. Each figure shows a cordless drier designated generally 300 including a fan 302, a burner 304, end nozzle 306, battery pack 308 and gas canister 310. The fan 302, burner 304 and nozzle 306 define a generally linear axis 312 with the burner 304 intermediate the fan 302 and nozzle 306, but various configurations of the remaining components are contemplated. In each case the design avoids obstruction of the airflow through the fan, to keep the power required to drive the fan to a minimum.

Referring to Figure 5 the battery pack with larger capacity cells is slung below and parallel with the axis 312, in a 2x2 configuration forwardly of the fan 302. The gas canister 310 projects perpendicularly below the axis 312, between the fan 302 and battery pack 308, and can be received in a handle significantly spaced from the burners, enhancing safety. In Figure 6 the positions of the battery pack 308 with larger capacity cells and gas canister 310 are reversed away from the burners, increasing their capacity. In Figure 7a and 7b the arrangement is shown with the gas canister 310 positioned along the axis 312 but rearwardly of the fan 302, and having a more squat configuration.

Referring to Figure 8a and 8b the arrangement is similar to that shown in Figure 6 but with the gas canister 310 placed above rather than below the axis 312.

The arrangement of Figure 9a and 9b is similar to that of Figure 6 but with the profile of the gas canister 310 varied slightly so as to taper from the base up.

Referring to Figure 10a and 10b the configuration is similar to that of Fig 7 except that the orientation of the fan is changed. In particular, it lies below and perpendicular to the axis 312, impelling air towards the axis. As a result a suitable deflector would be required to divert the air towards the burner.

Figure 11a and 11b is also similar to Figure 7 except that the gas canister 310 is more elongate, as is the fan 302 housing. Also the battery pack 308 is provided in a 4x1 configuration.

Referring lastly to Figure 12a and 12b all of the components are aligned with the axis 312. The gas canister extends along the axis rearwardly of the fan 302 and the batteries are distributed around its circumference. In the embodiment shown the batteries are provided at 90° intervals in grooves provided in the outer wall of the canister.

Turning in more detail to aspects of the invention, control and safety circuits control the motor speed, burner level, burner ignition and provide safety shutdown in the case of various failure modes. As the controls and burner are likely to be physically remote, purely mechanical controls and safety features are less desirable. As an electrical power source is available (for the motor), at least part of the gas control system is preferably electrically powered and/or sensed. This provides the most versatile method of control, is the least involved and risky from a development point of view, and allows controls almost identical to a standard corded hairdryer.

Referring to the control and safety circuit block diagram shown as 399 in Figure 3, the rechargeable battery pack 400 supplies all electrical power to the hairdryer. The positive supply from the battery is switched through a mechanical on/off switch 402. In the off position no power is available to energise the normally closed (spring return) solenoid operated gas shut-off valve 404, comprising a reservoir valve.

When the switch 402 is in the on position, the fan is switched on and the live connection from the battery connects to a vane type airflow switch 406. This consists of a plastic moulded vane and microswitch. When

the fan is on and the airflow is above a minimum value the switch 406 closes and the battery supply 400 is connected to the over-temperature thermal switch 408. In an alternative embodiment it is possible to omit the flow switch 406 and rely purely on the over-temperature switch 408 to detect reduced or absent airflow.

The over-temperature thermal switch 408 of any appropriate type, is placed in close proximity to the burner to detect excessive heating for any reason (excessive burner level, restricted airflow, or failure of the fan/motor). If this switch 408 opens due to excessive temperature, power will be disconnected from the solenoid valve 404 shutting off the gas supply 414. The hystereses of this switch 408 should be such that it will not close again until temperature is in the range where the under-temperature switch 416 has opened - preventing the possibility of the gas valve 404 being re-opened as the unit cools down.

The next components in the safety circuit 399 are the under-temperature thermal switch 416 and an override switch 418 connected in parallel. Except when the override switch 418 is held in the ignite position by the user, the under-temperature thermal switch 416 (of any appropriate type) will be open whenever the burner temperature is below a pre-determined value (indicating the burner 410 has not been or is not lit). This removes the supply to the gas control valve 404, switching off the gas supply, if the gas burner 410 is not lit.

Both the over-temperature and under-temperature switches comprise condition sensors which are provided on the baffle 56 shown in Figure 1.

In order to initially light the burner 410 the override switch 418 is moved to the ignite position which momentarily bypasses the under-temperature switch 416 to provide power to open the gas valve 404. The override switch 418 also provides power to the burner ignition circuit 420 to ignite the gas. As the power supply to an electronic igniter circuit is hardwired through the safety circuit, it is not possible for the igniter circuit to operate unless the switch 418 is in the ignite position.

Once the gas ignites, after a few seconds the under-temperature switch will close and the power supply 400 will remain connected to the solenoid valve 404 after the override switch is released. An opto-isolated monitoring circuit 422 determines whether the under-temperature switch 416 has closed in order to illuminate an LED indicating that the burner has lit. This monitoring circuit 422 has no effect on the safety circuit and is provided purely as an indicator 424 to the user that the gas is lit and they can release the ignite/override switch 418. Failure of this monitoring circuit 422, whilst it may erroneously indicate whether or not the burner is lit, has no effect on the safety shutdown functions of the gas supply.

An alternative approach is to permit a momentary actuation of the igniter switch to maintain gas flow, as well as operation of the ignition mechanism, (described further below) for a fixed short period of time unless the under-temperature switch closes. In that case, burner ignition is indicated and gas flow is maintained and operation of the ignition mechanism halted. If the burner fails to light, then the gas flow automatically ceases after such period.

In the case where the gas shut-off valve 404 also provides regulation of heat level using for example pulse width modulation of the on/off period of the valve, an opto-isolated signal via isolator 426 for the electronics switches the power on/off to the solenoid valve via isolator 426. Failure of the electronics can never switch on the control valve when the other hardwired safety components indicate a failure condition.

In the case where gas regulation is accomplished using a manual regulator valve 428, the opto isolated control circuit 426 is omitted and the gas solenoid valve 404 is connected directly to the terminals of the under-temperature and override switches 416, 418.

However, the former approach is preferred for two reasons. Mechanically variable gas flow regulators are difficult and expensive to manufacture if they are to avoid problems of spitting liquid gas. Much less expensive and currently widely available are on/off valves used in cigarette lighters. By pulsing operation of such valves, shots of gas are released into the conduit upstream of the valve. As mentioned above, the burners include a porous plug 42 that serves as a restrictor so that, even though the pressure upstream of the plugs 42 vary during each On-Off cycle, the flow through the restrictor is relatively constant and dependent essentially on the average pressure in the conduit. By varying the On-Off periods, the flow through the restrictor can be adjusted between zero, minimum and maximum flow rates.

Motor control is not critical to the safety of the hairdryer, and therefore can be controlled

electronically, as failure leading to overheating is detected by the hardwired over-temperature switch (and airflow switch if necessary). However safety critical components such as the solenoid valve 404 are hardwired using electromechanical components. Furthermore the HT supply 430 to the igniter 420, and the connection to the solenoid valve are electrically opto-isolated via respective isolations of any appropriate type 432, 426 in the electronic control circuit 434.

According to this arrangement, the safety critical circuits cannot be compromised by failure of the electronics. The use of optical isolation components to prevent any monitoring or control circuits of the electronics providing power or incorrectly enabling part of the safety circuit ensure this. Failure of the electronic control circuits may prevent operation of the hairdryer, but always in a fail-safe manner.

The safety circuit shuts off the gas supply in the event of failure to ignite the gas burner (or subsequent extinguishing of the burner, either controlled or due to a failure), an over-temperature condition (due to failure of the fan/motor, blockage of airflow etc.) or airflow less than a minimum level.

As regards motor control and electronic gas regulation, there are two embodiments presented regarding the gas regulation (to provide different heat settings). One uses a manual regulator valve 428 to provide variable heat control and the other modulates the on/off period of the gas shutoff valve to control the average gas flow.

The advantage of the electronic control of the solenoid valve is the reduction of mechanical parts

(albeit at the increase of electronic control) and mor freedom in the mounting position and type of controls.

The electronic control circuit (ECC) 434 which is preferably a printed circuit board provides, in addition to the possible PWM control of the solenoid valve; PWM speed control of the fan motor 42, igniter circuit 420, if desired, battery monitoring circuit and low battery display LED 436, burner lit monitoring and display LED 424, mounting platform for on/off/ignition switch, mounting platform for burner and motor control switches 438,440, and mounting platform for gas solenoid valve 404 and a "junction box" for electrical cabling.

A possible arrangement 499 of the control switches and indicators for a hairdryer according to the invention is shown in Figure 4.

A single on/off slide switch 500 controls all power from the battery pack to the hairdryer. When this switch is in the "off" position 502, all power is removed from the electronics, fan motor and solenoid gas shut-off valve ensuring that the gas source is closed. The on/off slide switch 500 is recessed and must be depressed before it is possible to move it from the off position. This is to minimise the possibility of accidental operation.

Moving the switch to the "on" position 504 provides power to the electronics and motor control circuits. The fan will run at the speed selected by the "fan speed" control switch 512. This can be a 2 position switch giving two fan speeds, or a number of speed settings. The gas is still turned off at this point.

The on/off slide switch 500 has a third momentary

spring loaded position 506. This is the "ignition" position where the user must hold the switch to ignite the gas. Moving the switch to this position opens the gas valve and turns on the HT spark igniter 420 (Figure 3). Once the burner has lit, a temperature sensor detects this, an LED lamp 508 lights to indicate gas lit, and the user may release the switch 500 back to the "on" position 504. If the user releases the switch before the gas lights, the gas supply will be switched off, and hairdryer will continue to blow out cold air. The switch must again be moved to the "ignite" position 506 to switch on the gas supply and enable the ignition circuit.

As mentioned above, however, an alternative arrangement provides for effectively automatically holding on of the igniter switch for a short period of time.

The heat level is controlled by a switch (or manual regulator) 510 giving two heat levels or a number of heat settings.

After use the user moves the slide switch to the "off" position 502. This stops the fan and closes the gas supply valve. To re-ignite gas supply the user must repeat the ignition sequence.

A "cool shot" option is also possible involving extinguishing and re-igniting the burner. Cold air operation is possible by switching the unit to "off", then moving the switch to "on" without igniting the gas.

However, a preferred arrangement is to provide a third operator switch 430 in the circuit arrangement 399. In this, the gas flow is simply regulated to flow at a

minimum level sufficient to keep the gas combustion going so that it can subsequently be raised again once the cool shot switch 430 is released, but at such a low level that the temperature rise of the air flowing through the hairdryer is minimal compared to normal. This more precisely mimics the traditional approach to cool shots and minimises operator actions to effect and cease the cool shot function. In this approach, it may be necessary to disable the under-temperature sensor switch while the cool shot is operating. Since minimal gas flows during this period, in any event, there is little or no danger. Moreover, the cool shot switch 430 one which is biased to its off position.

As regards ignition of the burner, a preferred implementation is the electronic spark ignition system 420 discussed above that repeatedly produces a spark until the gas has been lit, or the user releases the ignition button. Such an electronic system can be used in a similar fashion to a conventional mains powered dryer.

The cheaper alternative is a simple mechanical piezo-ignition system of any appropriate type. The piezo would be triggered once when the user moves the on/off/ignite switch 500 into the ignition position. The disadvantage is that the user will need to repeat the process if the burners fail to light, and this might not be apparent for several tens of seconds if the burners are not visible.

A presently preferred option is the use of a hot wire powered by the battery to light the gas. Again, this can be held on by the electronics until the ignition period has ended or the under-temperature sensor detects

gas ignition.

Further safety and related aspects include the placement of the spark electrodes, chosen to further minimise the risk of ignition of gas products due to the build up of silicone on the spark electrodes.

Also, to prevent hair ingress into the product a filter or grill is placed at the air inlet. This prevents hair being drawn in and becoming entangled with the fan and keeps other debris out.

Furthermore, to prevent debris drawn into the hairdryer (eg. fluff, hair, etc.) from being ignited by the gas burners and ejected as burning or very hot particles, firstly the air inlet filter will prevent most particles from being drawn into the hairdryer, and secondly, the risk of any particles that are drawn in, coming into contact with a flame or a very hot surface is minimised by the product design. In particular, the gas burners are catalytic and therefore burn without a substantial flame at temperatures of approximately 500-800C (rather than 1300C). Furthermore, these hot catalytic surfaces are protected from the intake air to maintain combustion. Thus particles drawn through the product are not exposed to high temperatures capable of posing a hazard.

Yet further, products that might reasonably be used with the hair dryer such as gels and hairsprays do not present a safety risk as a result of various features.

For example, airflow is controlled through the product so that aerosols etc are less likely to come into contact with surfaces that are sufficiently hot to ignite

them, the spark ignition source is appropriately placed, the operating temperature of the catalytic burners is reduced, and combustion occurs in a safe fashion with the hairdryer.

The invention as described herein is hence simple to use and similar in use to existing corded dryers. It provides gas shutdown in the case of failure of the burners to ignite, or extinguishing for any reason, two (or more) levels of heat output and fan speeds, gas ignition, reduced airflow detection and gas shutdown, over-temperature detection and gas shutdown, under-temperature detection and gas shutdown (which may be used to detect ignition failure), battery low indicator and burner on indicator.

Figures 13, 14 and 15 illustrate a presently preferred arrangement of hairdryer 10' in accordance with the invention.

Here, the housing comprises two moulded plastics, cup bodies 14',18' and two moulded plastics, handle clamshells 502,504. The cup bodies are mated together axially along their longitudinal axis to enclose the fan and motor assembly 21 and burner assembly 31. The clamshells mate together transversely to partially enclose and surround the cup bodies. The handle forms a loop that gives numerous holding options for the hairdryer. Significantly, however, this feature permits two important options to be realised. Given that hairdryers are a domestic item, most frequently employed by or for women, an aesthetically appealing design is important. By providing separate components for the handle and body, numerous colour and shape schemes can be achieved.

Figures 16 and 17 show the clamshells in detail with mating screw holes 506 and bosses 508. The rear 510 of the handle is open for connection and disconnection of the rechargeable battery pack (not shown). In Figures 13 to 15 they are shown at 512 as an integral assembly with the printed control circuit board. This is an option but a removable battery pack means that no waiting time is required while the battery is recharged if a spare battery pack is employed. In this event, the PCB is disposed in cavity 514 in the handle clamshells 502,504.

In Figures 18 and 19, the cup bodies 14',18' are shown in detail. Between them and the clamshells 502,504 a receptacle 516 is defined to receive a gas cartridge 310'. The cartridge, shown in Figure 26, comprises two canisters 310a,b held side by side by a neck tie 520 comprising a plastics moulding figure-of-eight snap fitted over the necks 522 of the canisters. The necks terminate in gas outlets 524 protected by integral valves. The bases of the canisters are received in a cap 526.

The cap 526, shown in more detail in Figure 24, includes a coupling part 528 in the form of a tab hinged to the cap by a hinge 530 formed by an arcuate slit 532 in the cap wall. The tab 528 includes a catch 534 adapted to snap into a corresponding eye 536 formed in the base of the receptacle 516 in the clamshells. The cap 526 also provides aesthetic design options since it forms a clearly visible and prominent part of the hairdryer. Not only can its colour be varied, but also different decalcomania can be added, or surface decoration provided.

Turning to Figure 20, a frame element 540 is shown on which the motor/fan assembly is mounted. The motor is contained within the cage formed by arms 542 of the frame and its base 544. The base has a central aperture 546 to receive the armature of the motor 20 to drive the fan received on the other side of the base 544 (see also Figure 15). Two side arms 542a,b have bosses 546 to receive screws (not shown) that connect the clamshells 502,504 to the frame 542. The screws locate in eyes 541 in the clamshells and pass through slots 548 in the rear cup body 14'. The arms 542 are hollow to receive screws that connect a modified rear (third) baffle 60' (shown in Figure 21), through the frame 542, to the rear cup body 14', which is provided with screw bosses 550 for this purpose.

The front cup body or nozzle 18' is connected to the rear body by way of a clip fitting 552/554 and a single retaining screw (not shown) received through eye 556 and in boss 558 in the nozzle 18'.

To the rear baffle 60', in bores 560 therein, are secured the rear ends of the burners 34. The first, exhaust baffle 54' is here mounted on a rearwardly extending rod 62' that is also mounted in the rear baffle 60', in a central bore 562. The burners 34 and rod 62' also pass through a modified front (second) baffle 56 that likewise has bores 564 to allow passage of the burners 34 and rod 62'.

Between the clamshells 502,504, in slots 571 provided for this purpose, is captivated a plastics moulded manifold 570 (see Figure 23). For the moulding purposes, this has an open end 572. However, this is plugged for use. The manifold has two inlet ports, each

comprising a sleeve 576 adapted to seal on an O-ring 578 disposed on the neck 522 of each canister 310a,b of the cartridge 310'. A central pin 580 in each sleeve 576 is adapted to actuate the outlet valve in each canister. In each case, the seal is made, and the valve actuated, on insertion of the cartridge in the receptacle 516. When inserted, gas can then communicate with the chamber 582 of the manifold. The manifold has a single port outlet 584 to which a common cigarette-lighter type of valve 586 is connected. This is actuated to open by being lifted, and, in this application, this is accomplished by a lever 588 pivoted about axle 589 between hinge bushes 590 provided in the clamshells 502,504. The other end of the lever is connected to the armature 594 of solenoid 592 whose electronic control is described above. The valve 586 is connected to flexible conduit 596 leading to the burners 34. The solenoid armature is biased towards a closed position of the valve 586. The sloenoid is located by and between bosses 593 formed in the clamshells 502,504.

Finally, the electrical consumption of the hairdryer is very small. Accordingly the simplest electrical switching is adequate. What minimal current is taken is by the fan motor, which is switched externally only by the primary On-Off switch. In this embodiment, a simple toggle microswitch (not shown) is provided, and this is pivoted between the clamshells about hinge bushes 598 at the rear of the handle. However, even smaller current is employed by the control circuit to switch between fan power settings, heat control settings, and the cool shot function. The present invention therefore also provides that these switches (430,438,440) are implemented by bubble-membrane type switches mounted on a self-adhesive pad 602 (see Figure 27) adhered to a switch pad area 600

on each clamshell. A connection strip 604 extends through slots 606 in the clamshells to connect with the PCB. Because they are inexpensive, each switch is duplicated, one on either side of the hairdryer so that they are easily manipulated by finger or thumb whichever part of the handle is grasped by either hand of the user, and in whichever direction the hairdryer is pointed. Indeed, this is a feature of the present invention that at least one or more of these switches may be duplicated on the handle.

It will be appreciated that features and components from the various embodiments can be combined or interchanged as appropriate without departing from the inventive concept. The individual components described, to the extent they are generic or off-the-shelf products, will be well known to the skilled reader and hence have not been described in detail.

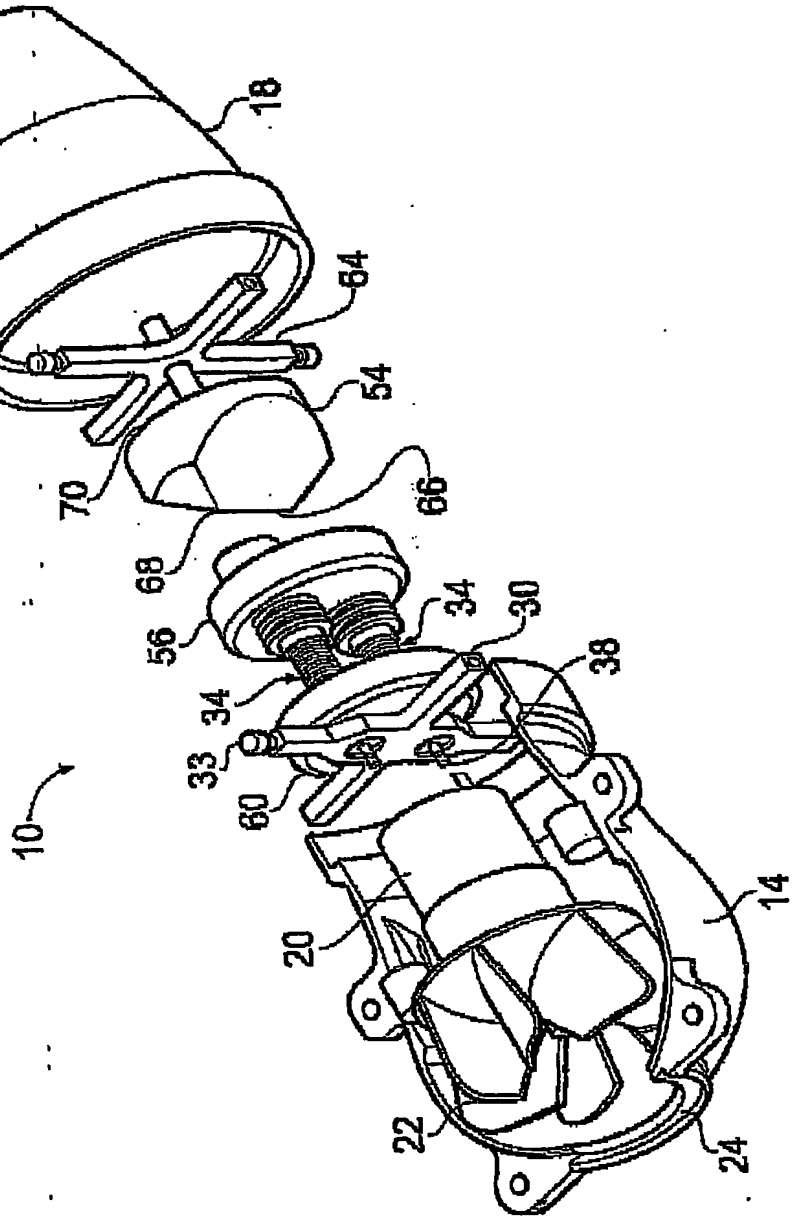
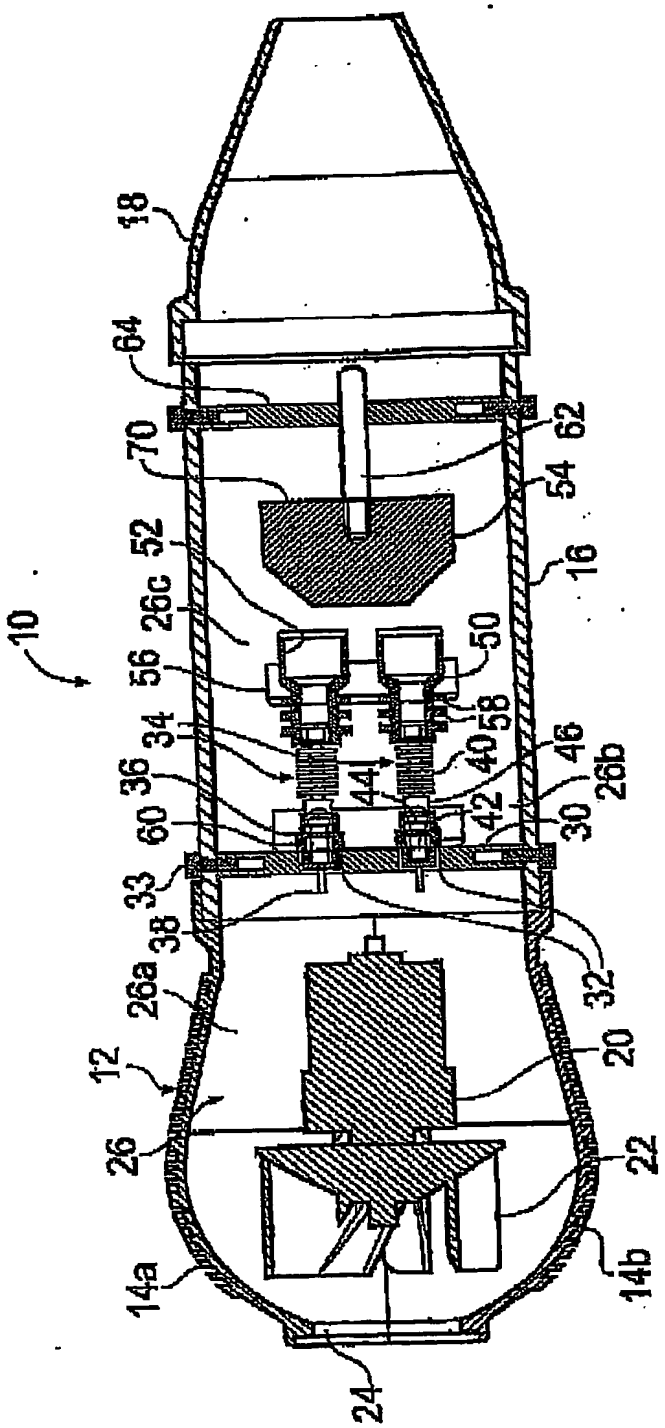


Fig. 1


10
12
14a
14b
16
18
20
22
24
26
26a
26b
26c
30
32
33
34
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42
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52
54
56
58
60
62
64
70

Fig. 2

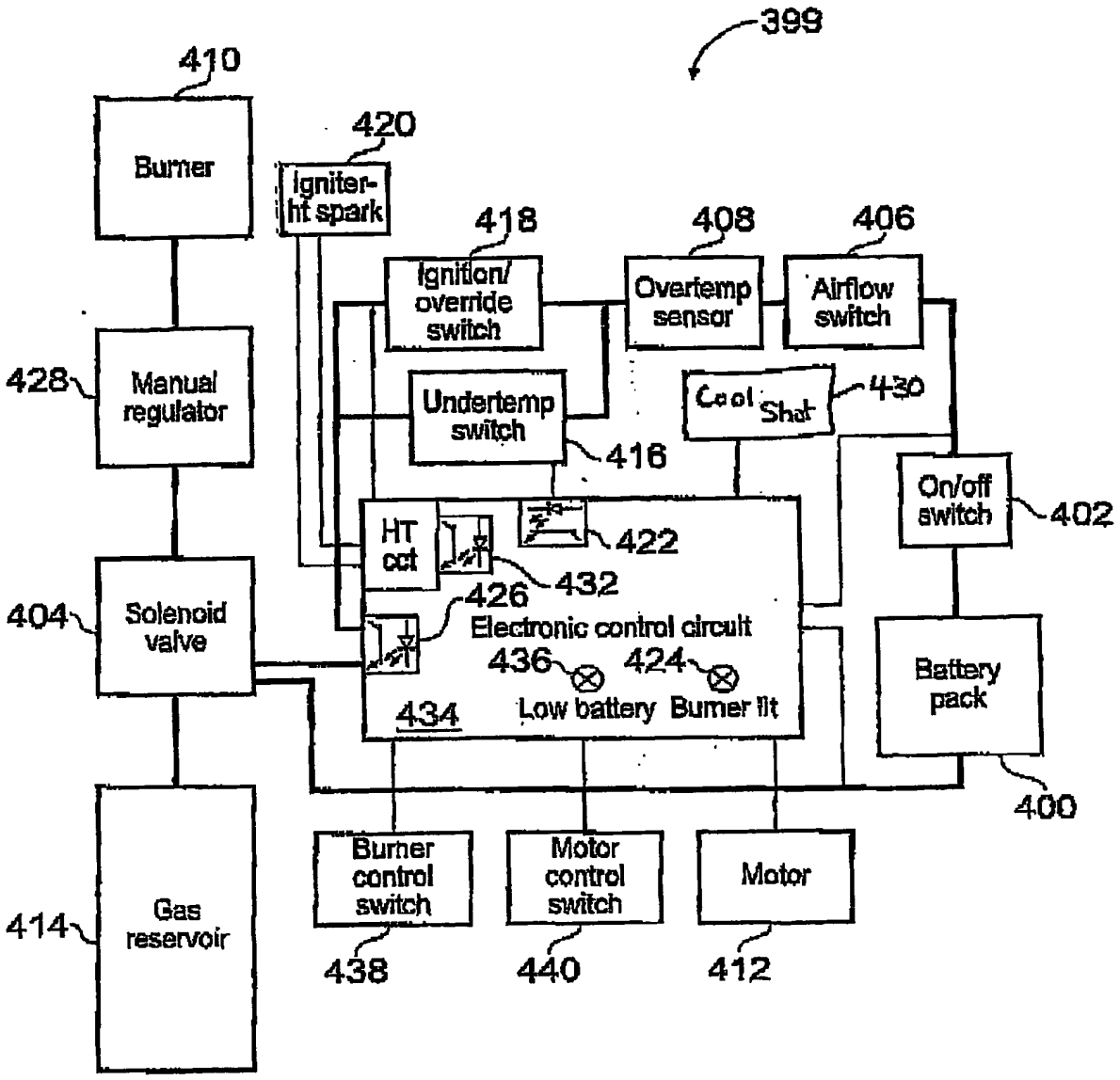

399
410
Burner
420
Igniter-ht spark
418
Ignition/ override switch
408
Overtemp sensor
406
Airflow switch
428
Manual regulator
Undertemp switch
416
Cool Shut
430
On/off switch
402
HT cct
422
432
426
404
Solenoid valve
Electronic control circuit
436
424
Low battery
Burner flt
434
Battery pack
400
Burner control switch
Motor control switch
Motor
414
Gas reservoir
438
440
412

Fig. 3

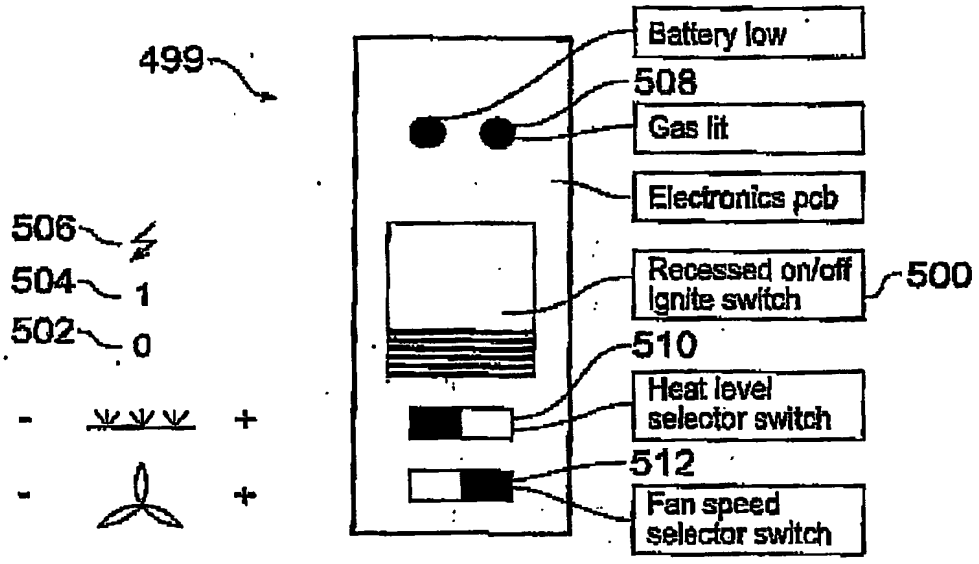

499
506
504
1
502
0
-
+
-
+
Battery low
508
Gas lit
Electronics pcb
Recessed on/off Ignite switch
500
510
Heat level selector switch
512
Fan speed selector switch

Fig. 4

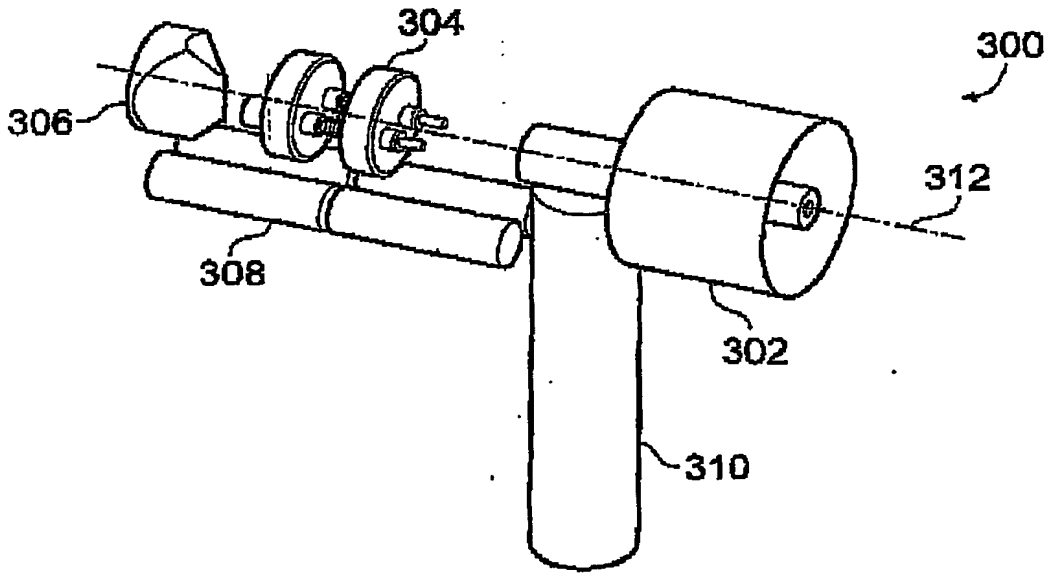

304
300
306
312
308
302
310

Fig. 5

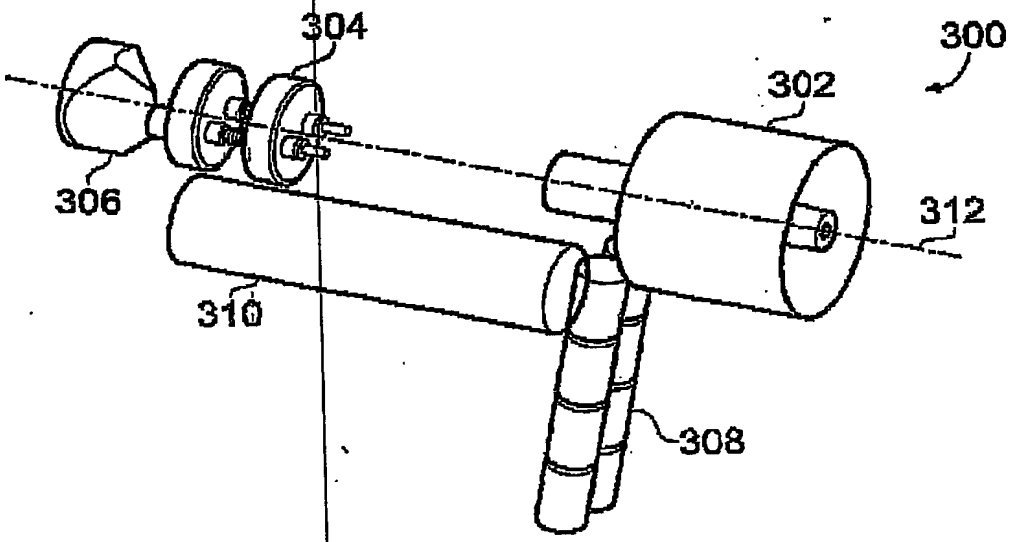


Fig. 6

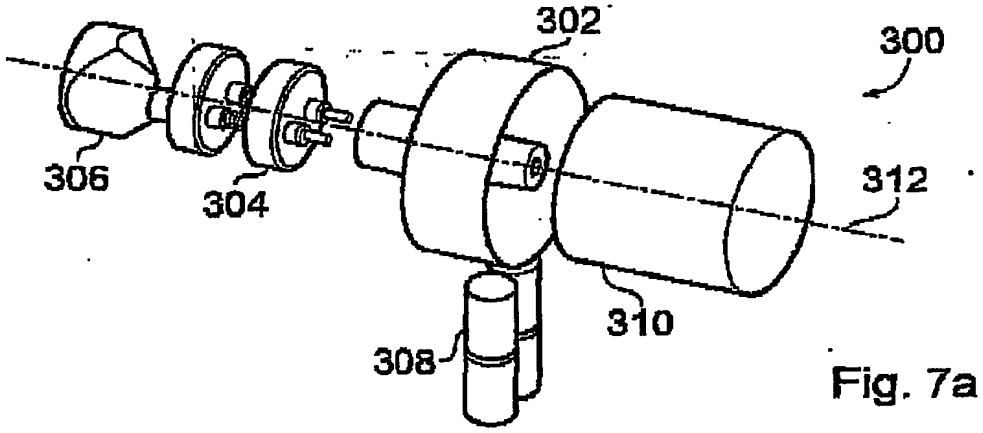


Fig. 7a

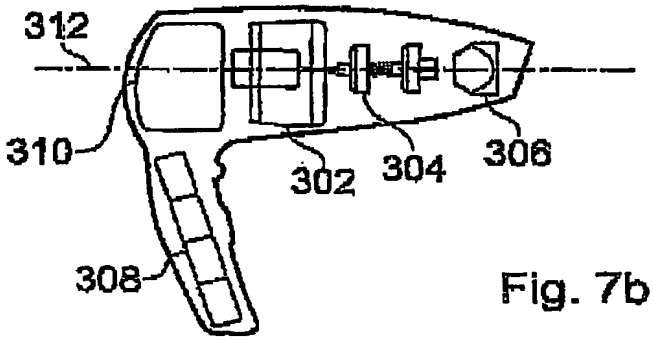


Fig. 7b

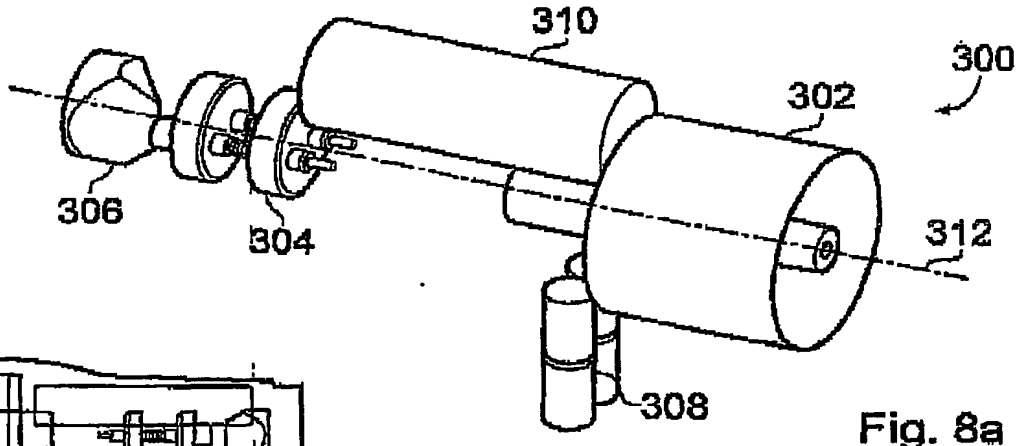


Fig. 8a

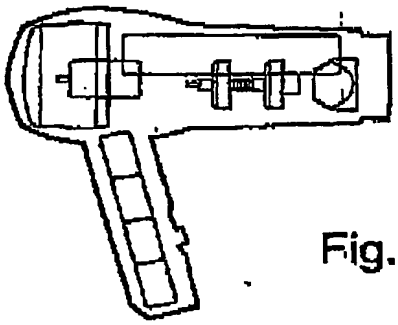


Fig. 8b

7123

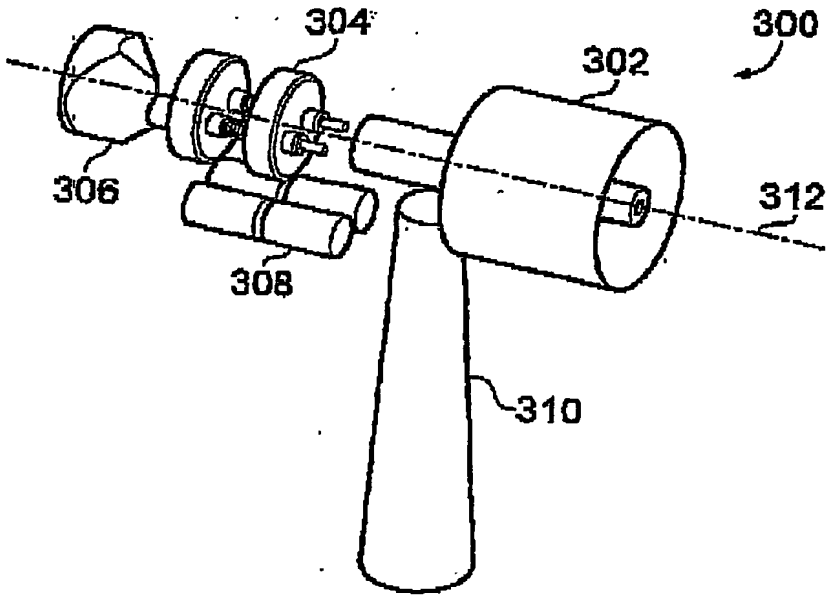


Fig. 9a

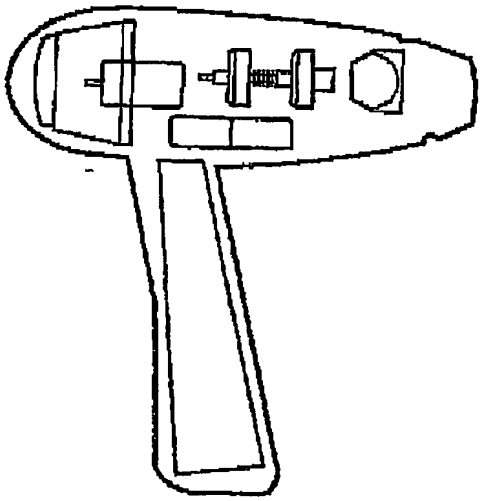


Fig. 9b

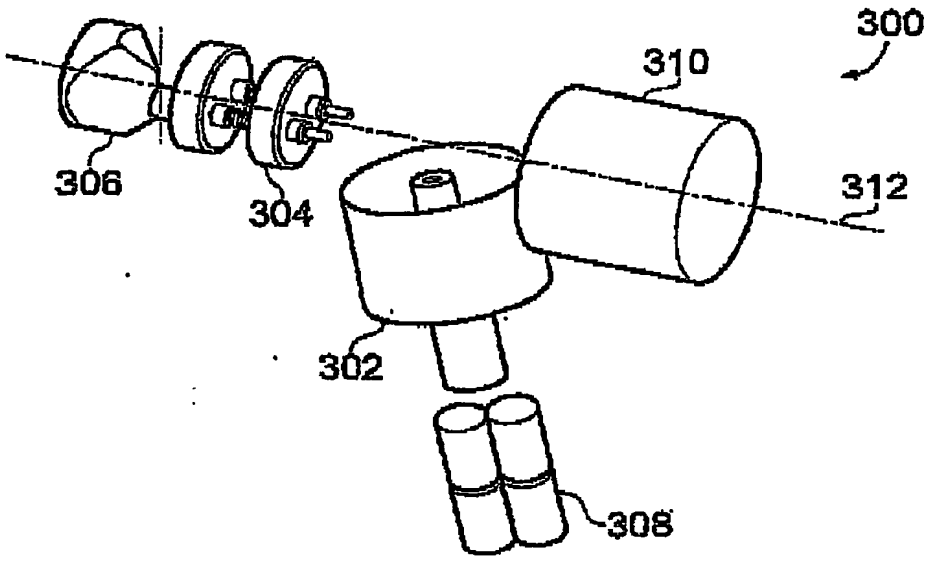


Fig. 10a

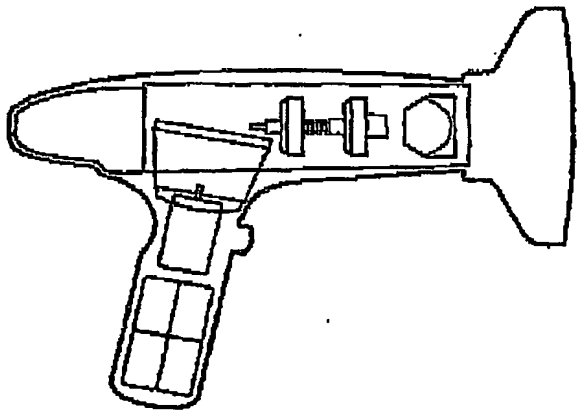


Fig. 10b

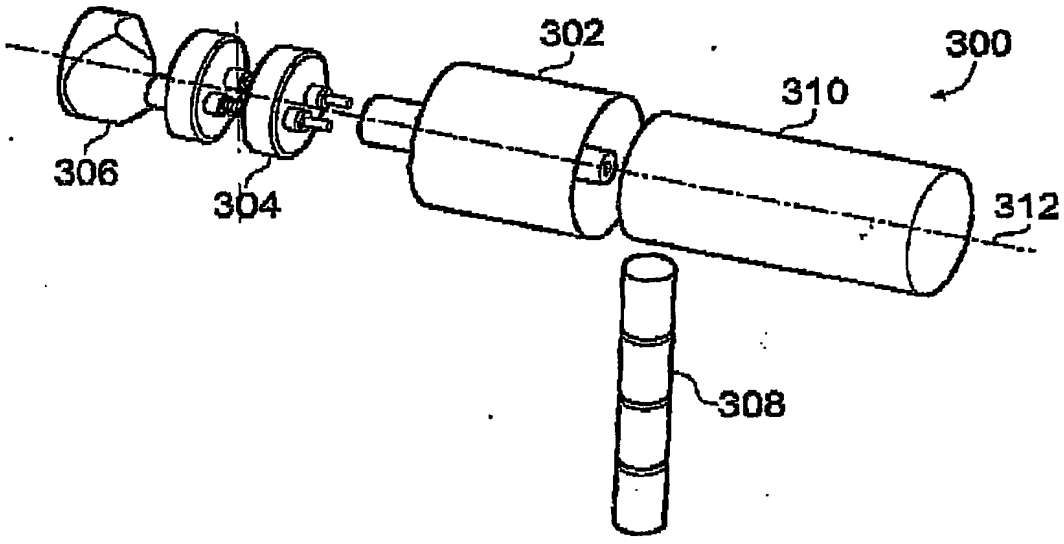


Fig. 11a

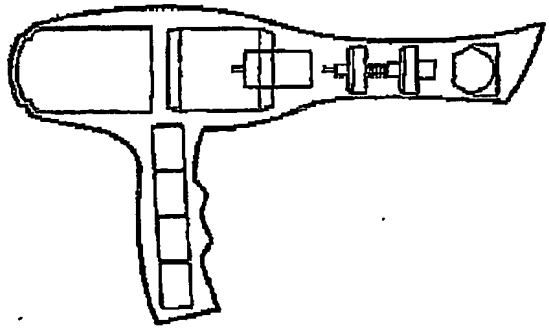


Fig. 11b

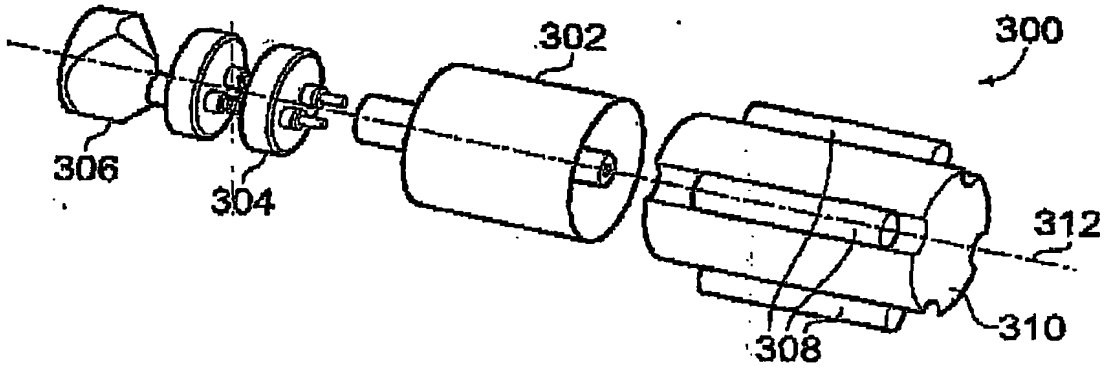


Fig. 12a

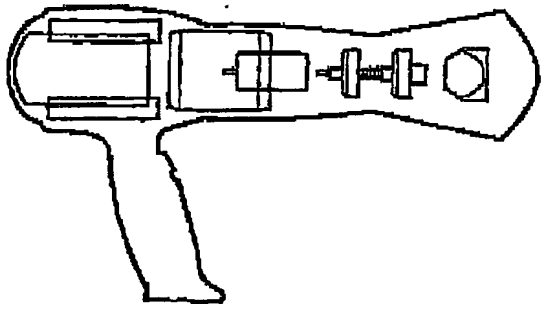
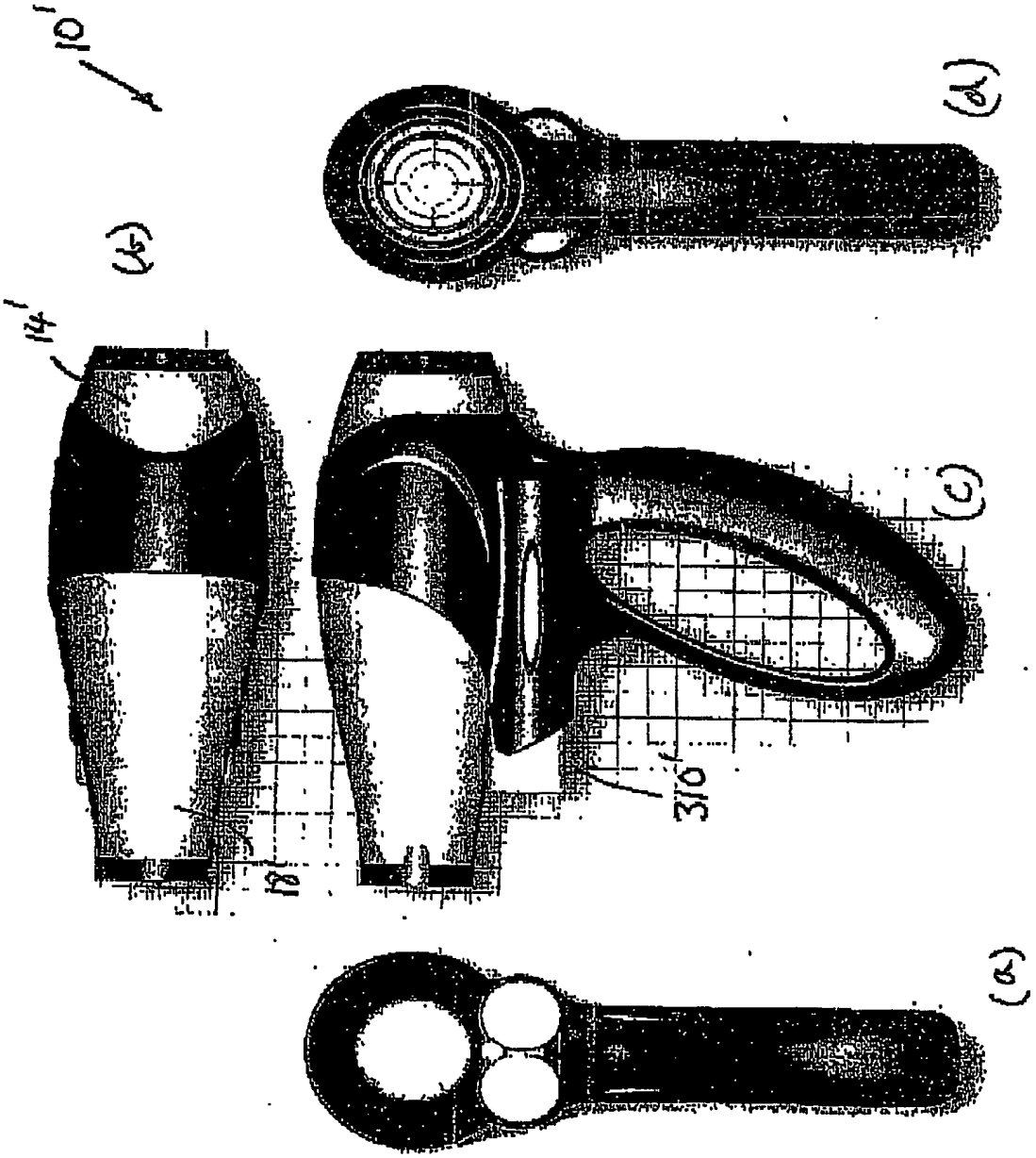


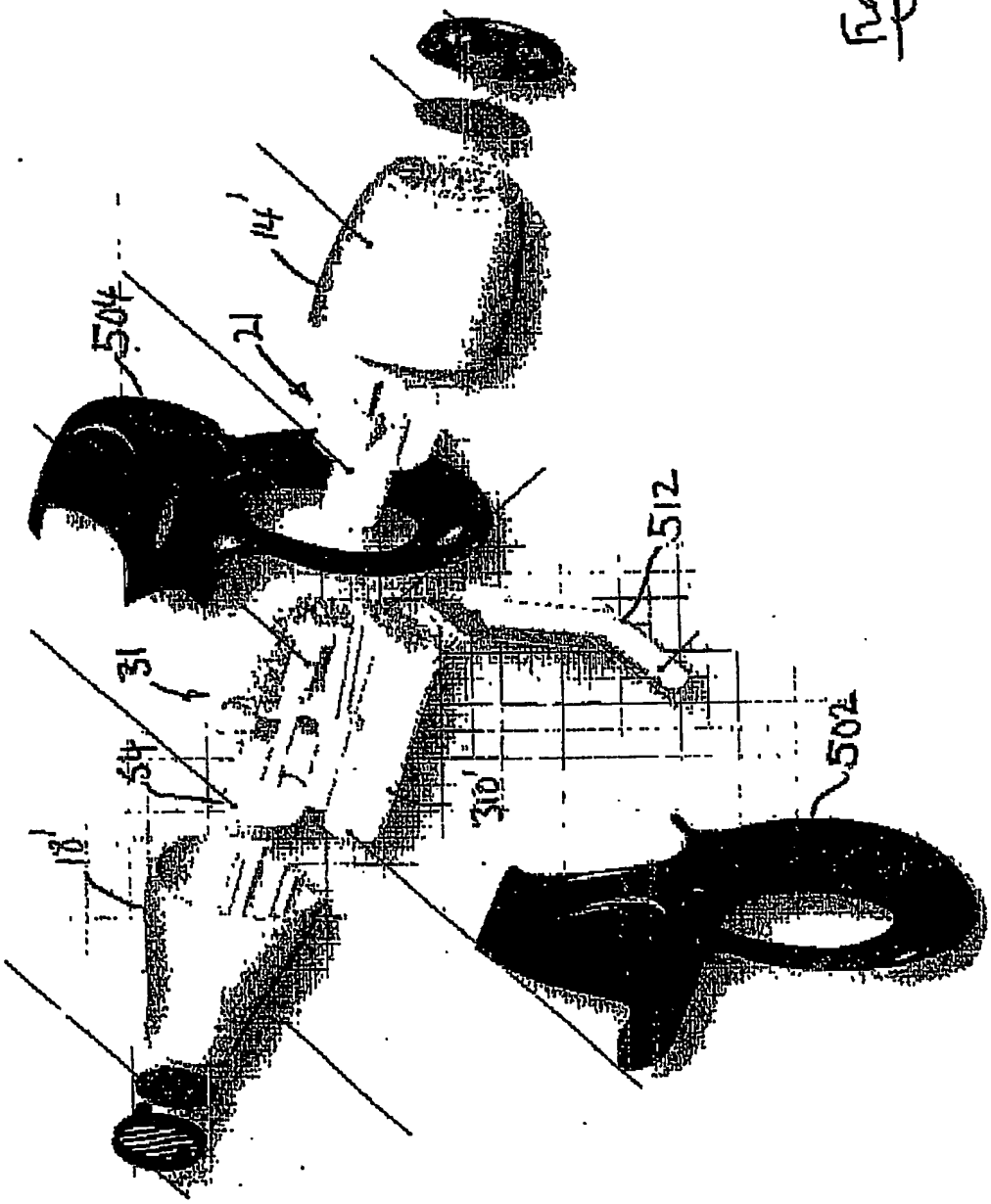
Fig. 12b

Fig. 1B



12/23

Fig. 14



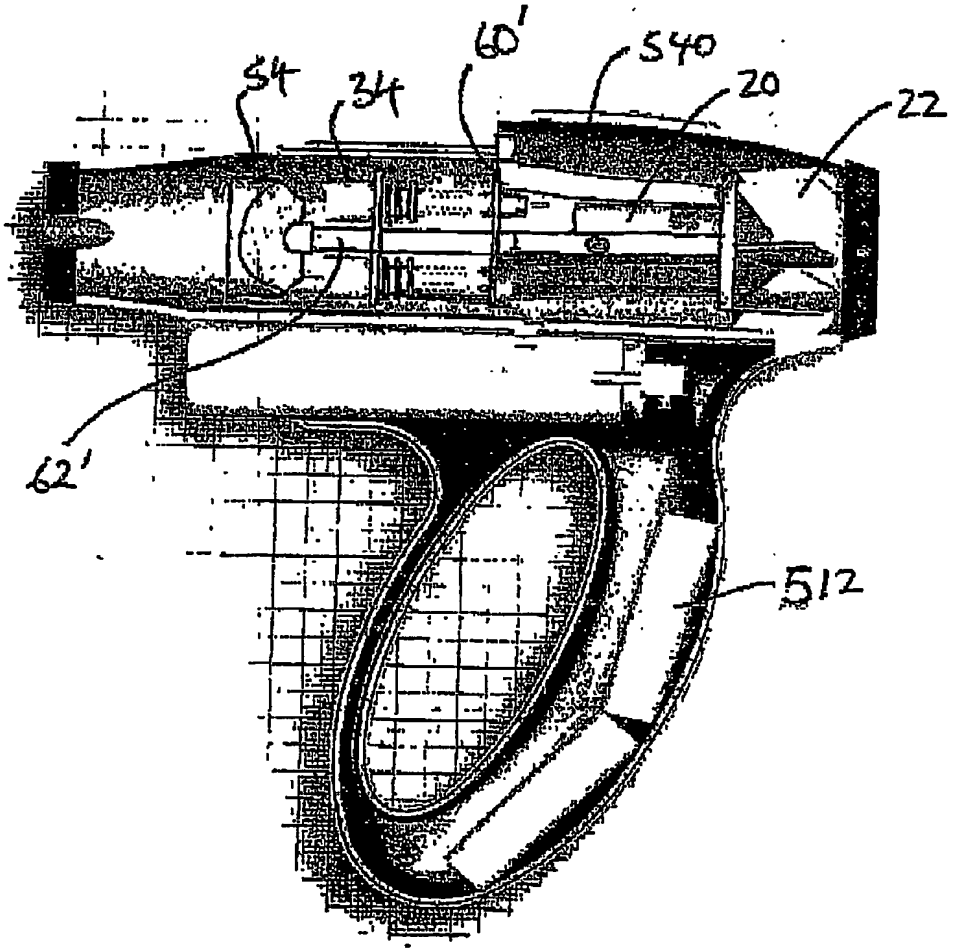
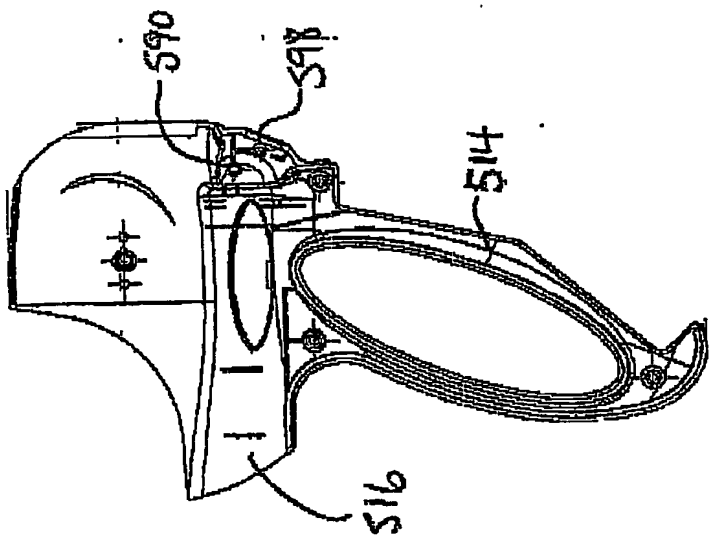
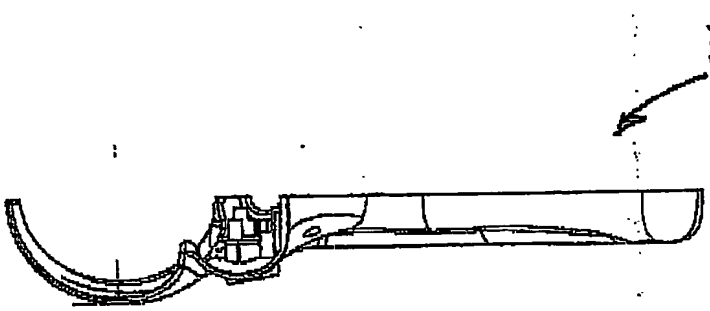


Fig 15

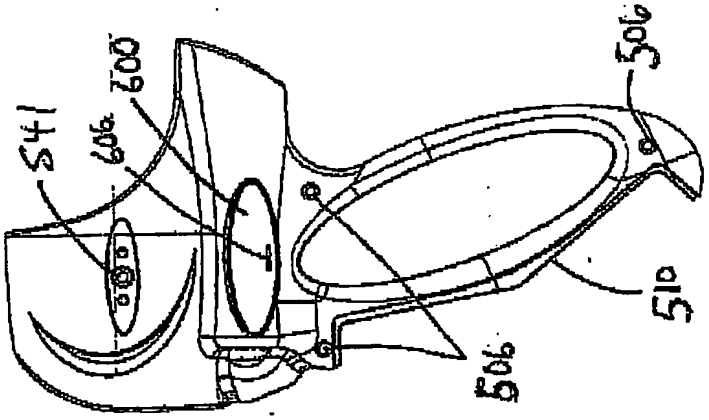


(c)

Fig 16



(d)



(e)

15/23

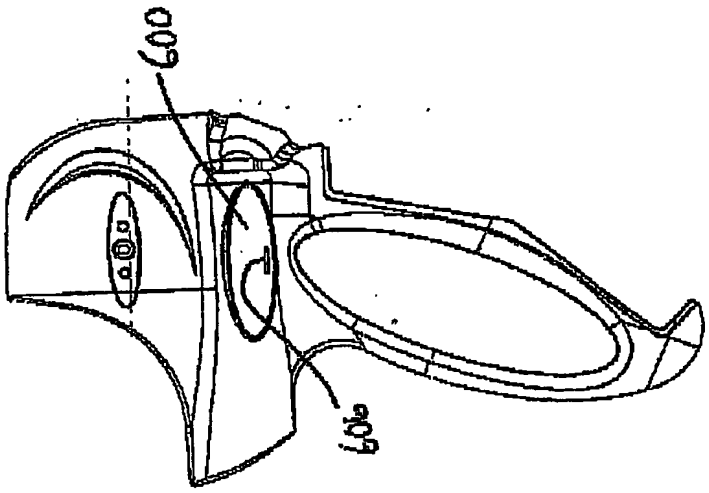


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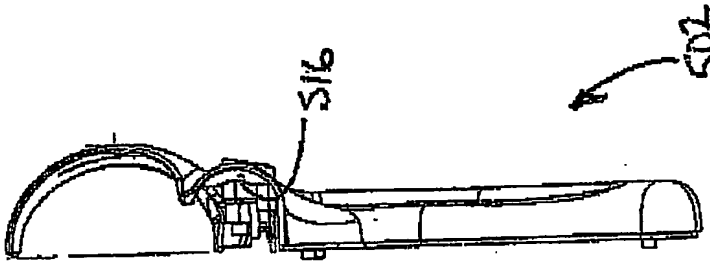
Fig. 17



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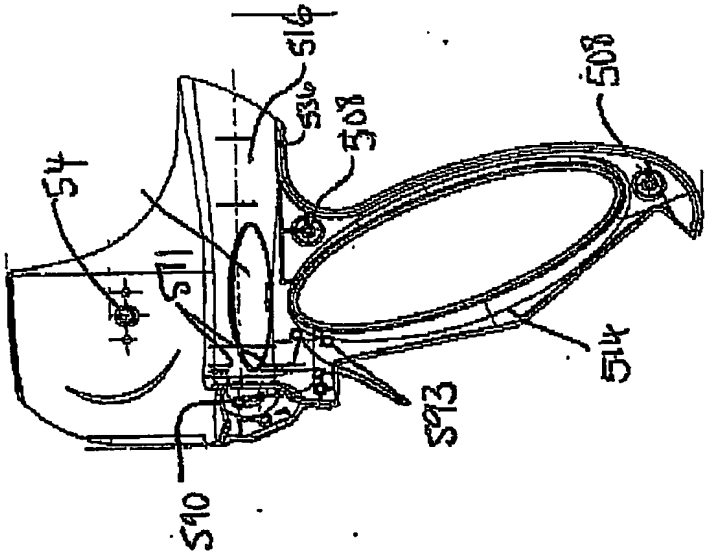


(e)

Fig 18

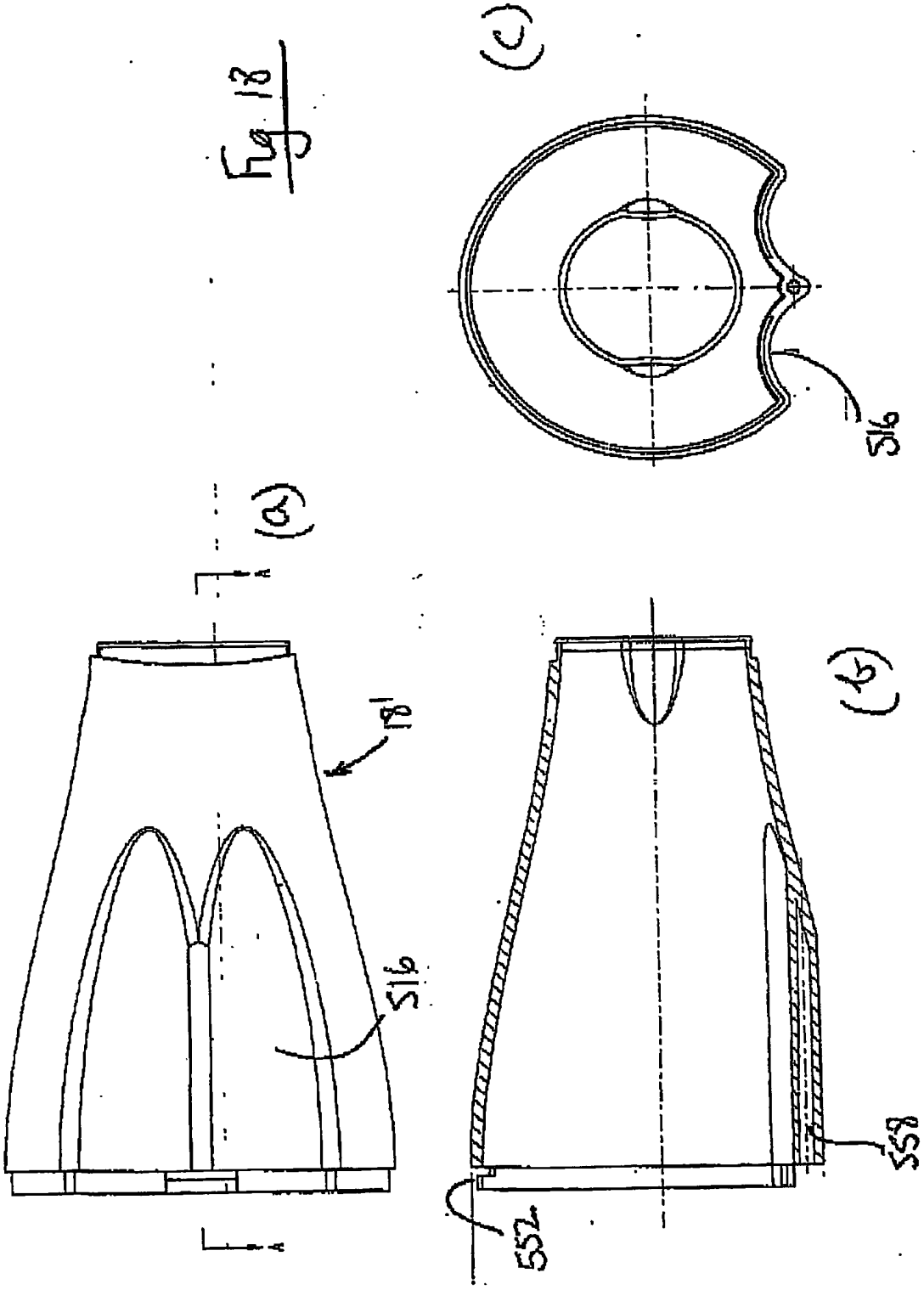


Fig 19

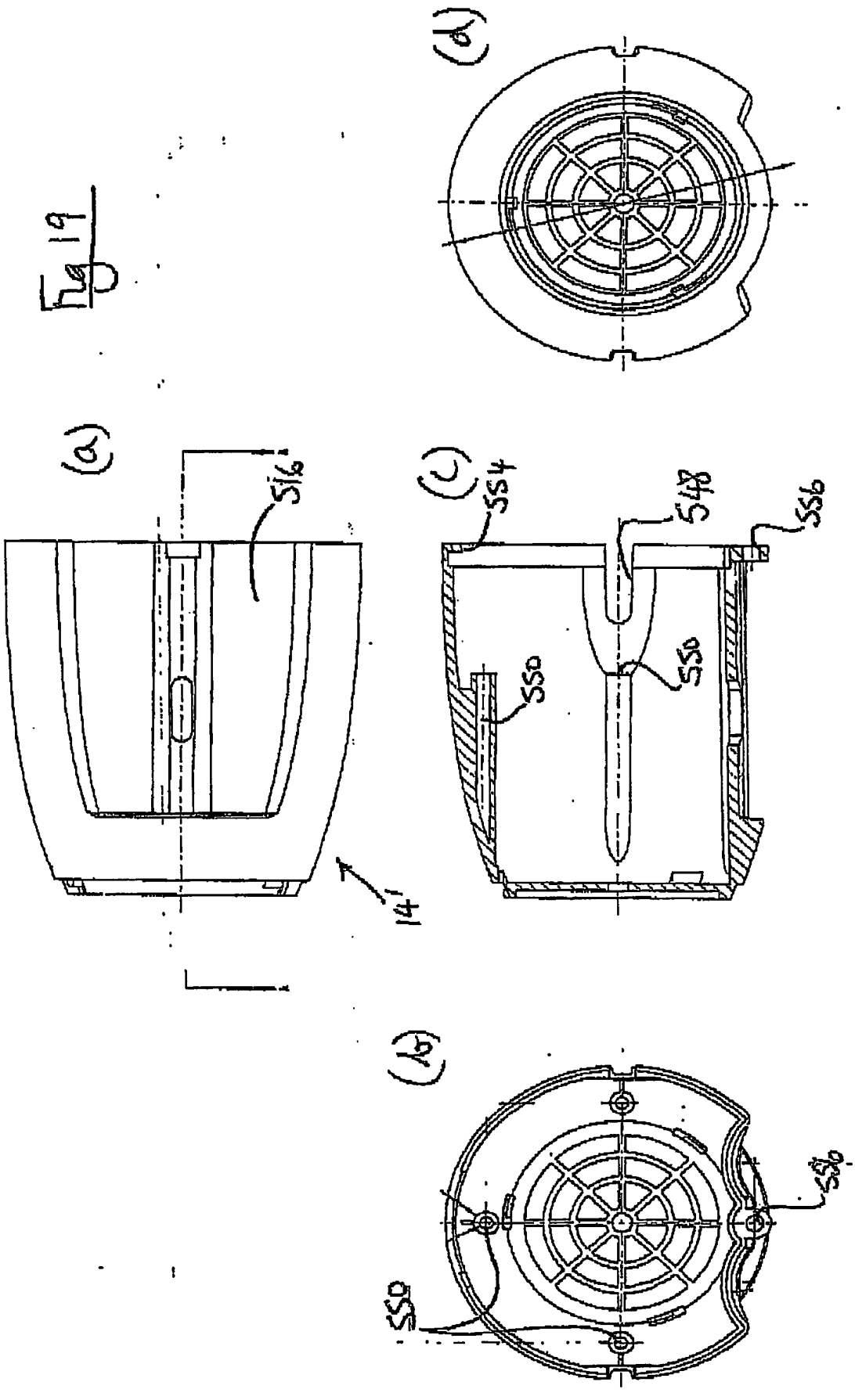


Fig. 20

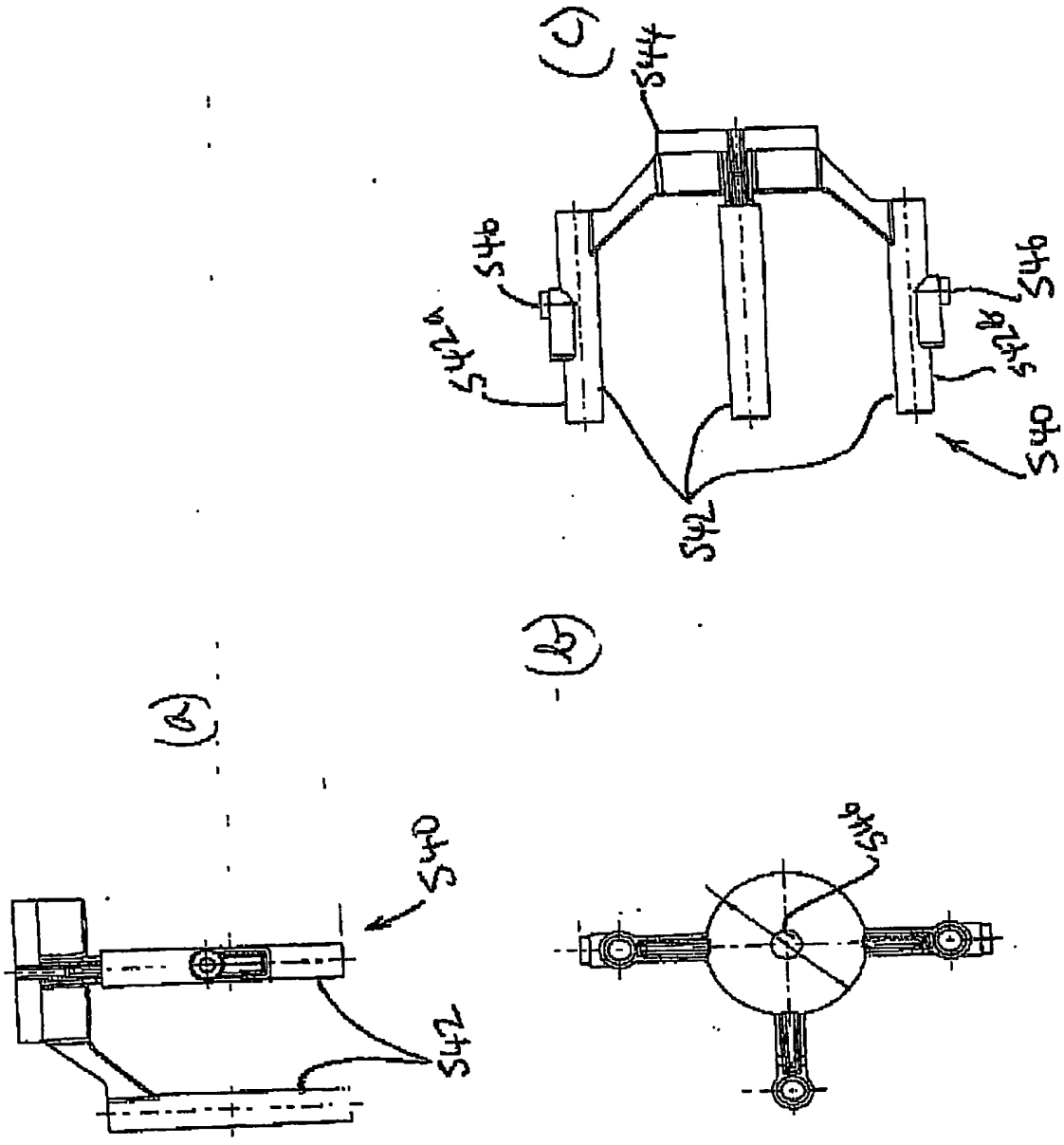


Fig. 21

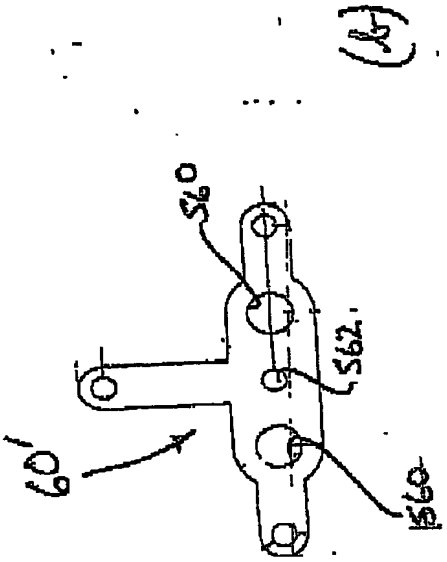


Fig. 22

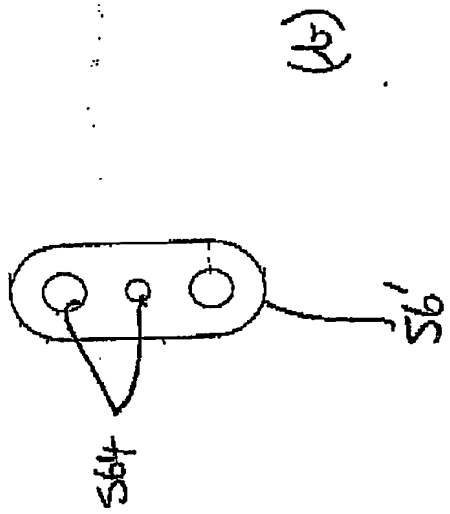


Fig. 23

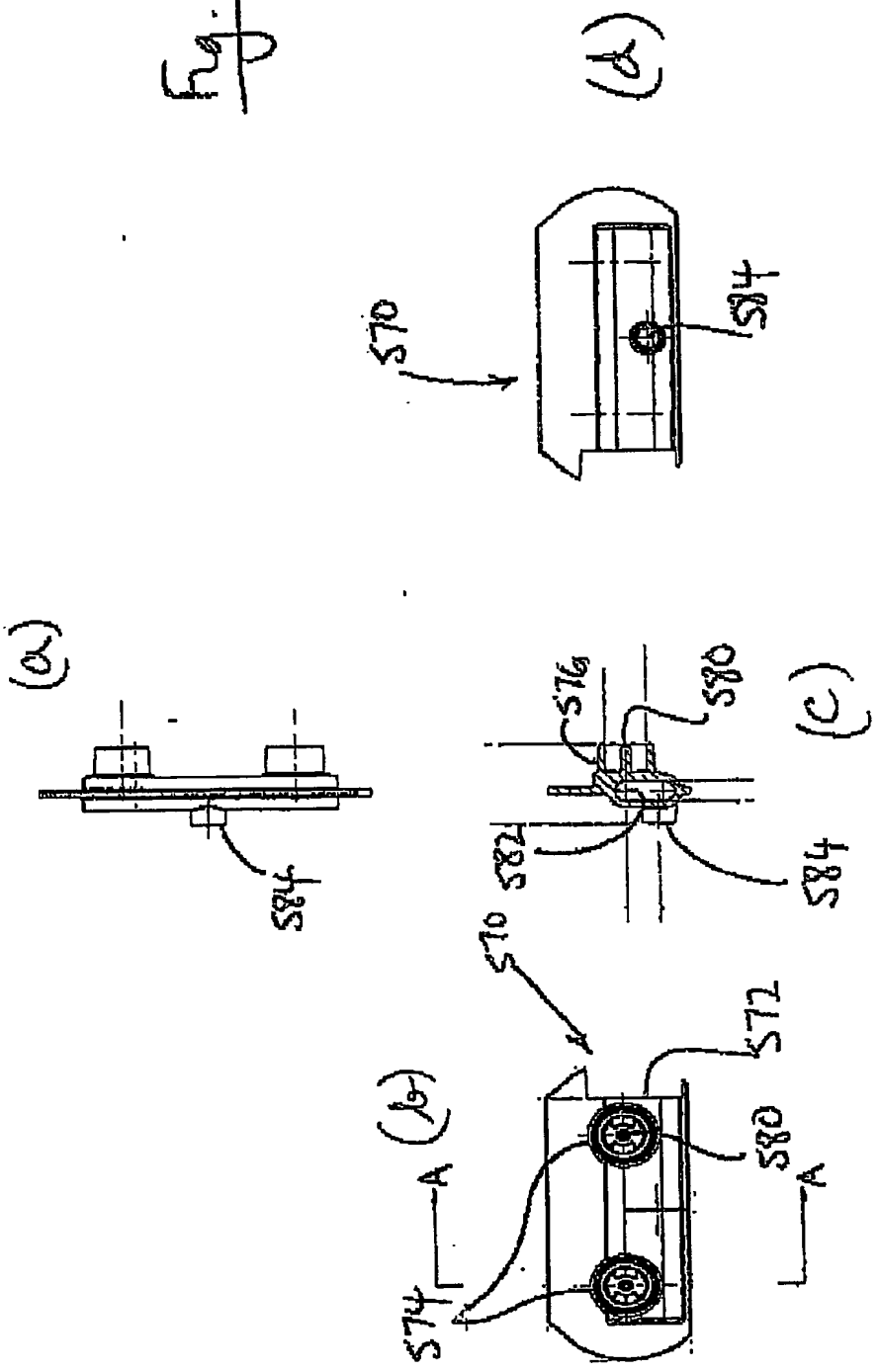
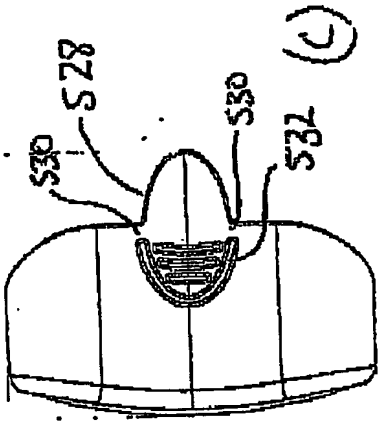
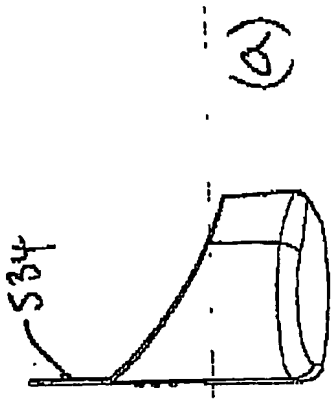


Fig. 24





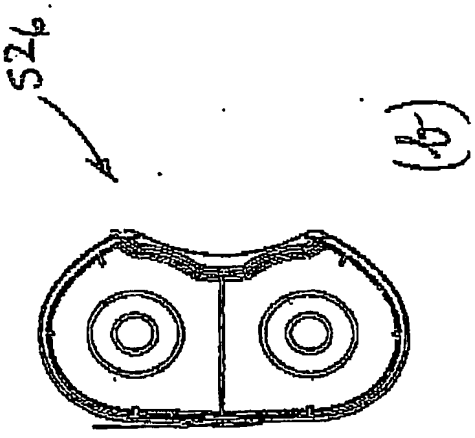


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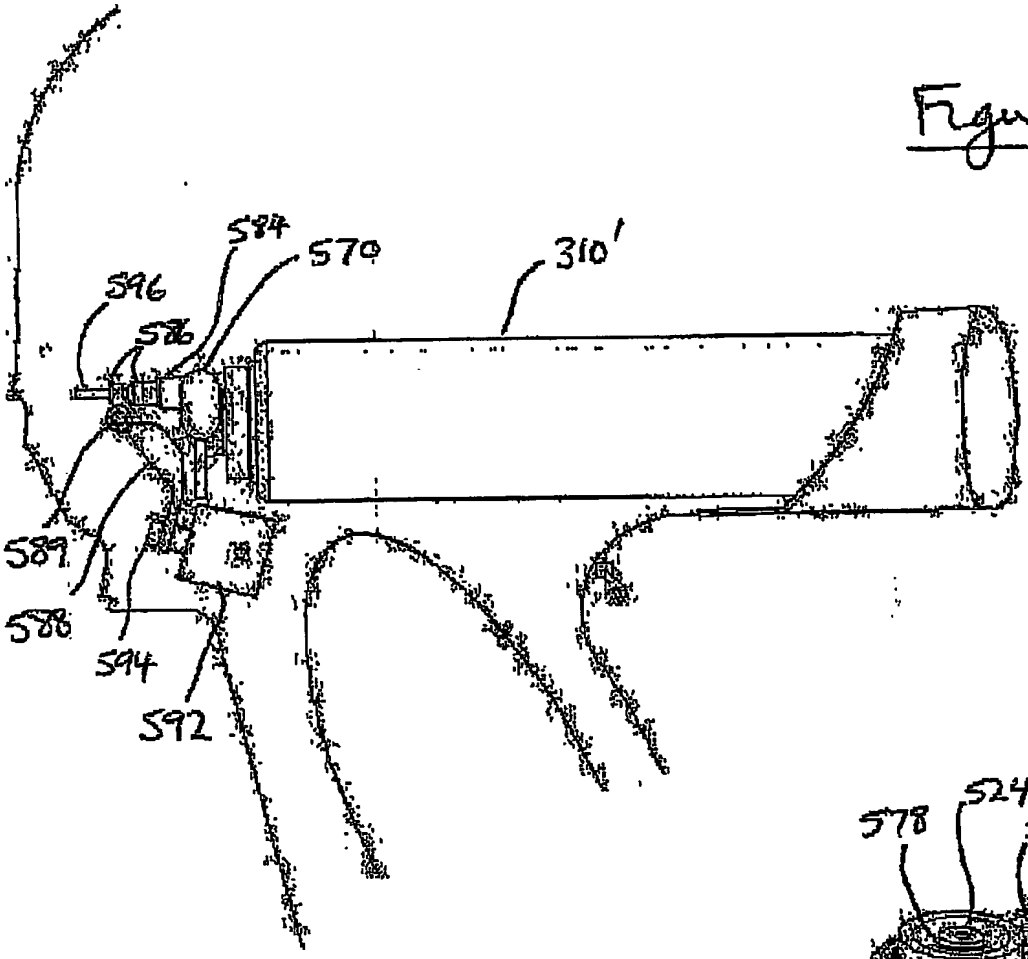
Figure 25



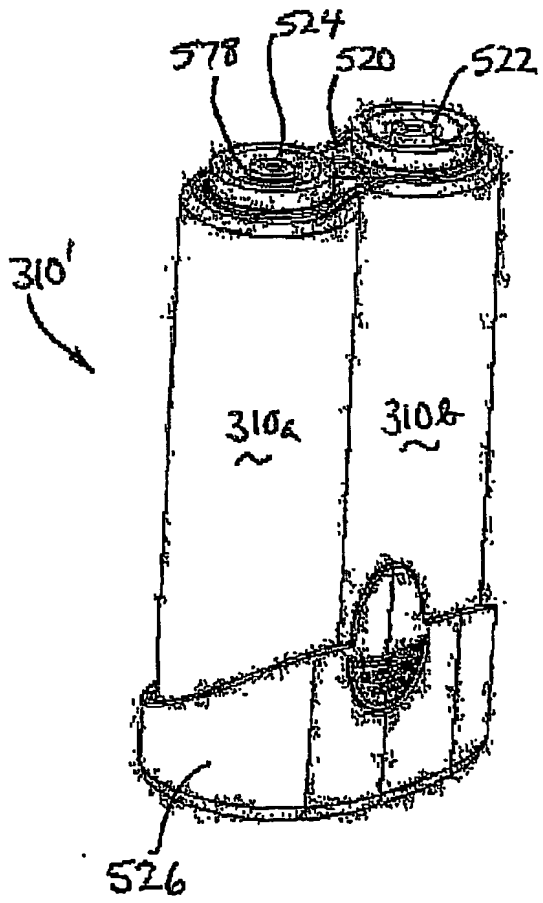


Figure 26

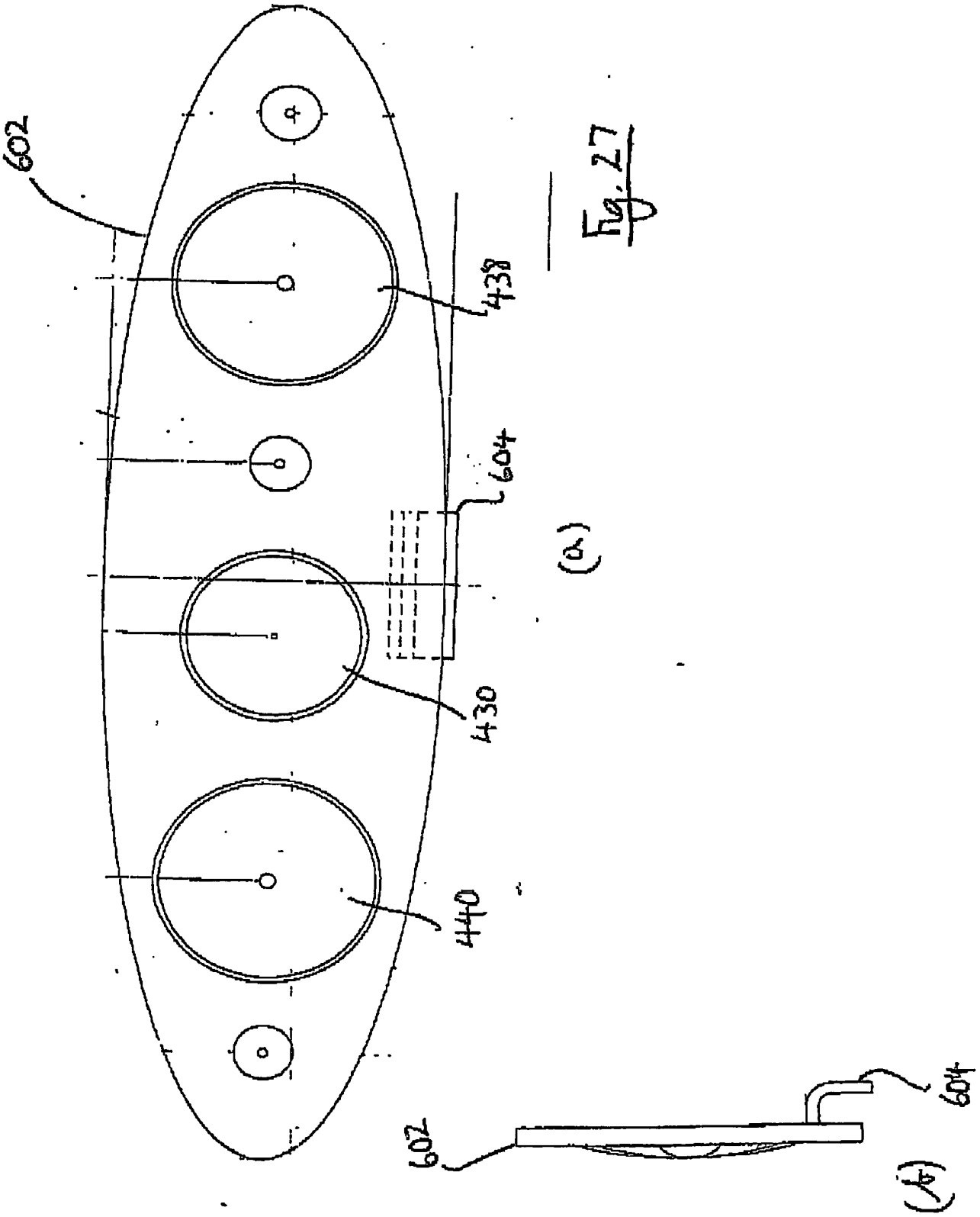


Fig. 27

PCT Application

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